IEA
SOLAR R&D

INTERNATIONAL ENERGY AGENCY

program
to develop and test
solar heating
and cooling systems

task III
performance testing of solar collectors

results and analyses of IEA round robin testing

Kernforschungsanlage Jülich GmbH
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Results and Analyses of IEA Round Robin Testing

Abstract

Two flat-plate collectors were subjected a round robin testing. Three procedures were applied to determine thermal performance. A total of 16 laboratories were engaged in the test. The testing facilities were situated in 12 different countries distributed over the northern hemisphere. The meteorological test conditions and systematic errors of the test facilities can fully account for the spread of round robin efficiency data.

The most pronounced contribution to systematic deviation is caused by the pyranometer. None of the procedures proved to be superior with respect to the data scatter.

The results from the applied procedures do compare very well.

This report is part of the work of the
IEA Solar Heating and Cooling Program.

Task III: Performance Testing of Solar Collectors.

Subtask A: Development and Application of Standard Test Procedures for Determining Thermal Performance.

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RESULTS AND ANALYSIS
OF IEA ROUND ROBIN TESTING

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PREFACE

INTERNATIONAL ENERGY AGENCY

In order to strengthen cooperation in the vital area of energy policy, an Agreement on an International Energy Program was formulated among a number of industrialized countries in November 1974. The International Energy Agency (IEA) was established as an autonomous body within the Organization for Economic Cooperation and Development (OECD) to administer that agreement. Twenty countries are currently members of the IEA, with the Commission of the European Communities participating under a special agreement.

As one element of the International Energy Program, the participants undertake cooperative activities in energy research, development, and demonstration. A number of new and improved energy technologies which have the potential of making significant contributions to our energy needs were identified for collaborative efforts. The IEA Committee on Energy Research and Development (CRD), assisted by a small Secretariat, coordinates the energy research, development, and demonstrations program.

SOLAR HEATING AND COOLING PROGRAM

Solar Heating and Cooling was one of the technologies selected by the IEA for a collaborative effort. The objective was to undertake cooperative research, development, demonstrations and exchanges of information in order to advance the activities of all Participants in the field of solar heating and cooling systems. Several tasks were developed in key areas of solar heating and cooling. A formal Implementing Agreement for this Program, covering the contributions, obligations and rights of the Participants, as well as the scope of each task, was prepared and signed by 15 countries and the Commission of the European Communities. The overall program is managed by an Executive Committee, while the management of the sub-projects is the responsibility of Operating Agents who act on behalf of the other Participants.

The tasks of the IEA Solar Heating and Cooling Program and their respective Operating Agents are:

I. Investigation of the Performance of Solar Heating and Cooling Systems - Technical University of Denmark

II. Coordination of R & D on Solar Heating and Cooling Components - Agency of Industrial Science and Technology, Japan

III. Performance Testing of Solar Collectors - Kernforschungsanlage Jülich, Federal Republic of Germany

IV. Development of an Insolation Handbook and Instrumentation Package - United States Department of Energy

V. Use of Existing Meteorological Information for Solar Energy Application - Swedish Meteorological and Hydrological Institute

VI. Performance of Solar Heating, Cooling and Hot Water Systems Using Evacuated Collectors - United States Department of Energy

VII. Central Solar Heating with Seasonal Storage - Swedish Council for Building Research

Collaboration in additional areas is likely to be considered as projects are completed or fruitful topics for cooperation identified.

TASK III - PERFORMANCE TESTING OF SOLAR COLLECTORS

A wide variety of collector designs with a broad range of qualitative differences exists. Since the collector is the key component in an active solar system, performance testing is a vital task. The objective of Task III is to develop internationally accepted testprocedures for determining the thermal performance as well as the reliability and durability of collectors. This project is also experimenting with the use of solar simulators to allow year-round testing of collectors.

The subtasks of this project are:

A. Development and Application of Standard Test Procedures for Determining Thermal Performance

B. Development of Reliability and Durability Test Procedures

C. Investigation of the Potential of Solar Simulators

The following countries are Participants in Task III:
Austria, Belgium, Canada, Denmark, Federal Republic of Germany, Greece, Italy, Japan, The Netherlands, New Zealand, Spain, Sweden, Switzerland, United Kingdom, USA, and the Commission of the European Communities.

This report documents work carried out under subtask A of this task. The cooperative work and resulting report is described in the following section.

1. Introduction

The promotion of solar technology in recent years has made evident the need for standardized methods for use in rating solar collectors. Efforts in several countries have resulted in the development of procedures to determine the efficiency of the collector over a range of operating temperatures. While it is well recognized that collector performance is also dependent upon system characteristics, it is necessary to make thermal performance and durability/reliability data available at an intermediate stage for comparison of collectors and for system design.
Since the methods of testing collectors should be generally applicable, practical and provide guidance for precise and accurate measurements, one had to resort to compromise. This resulted in a situation where the procedure itself - meeting a number of contradicting requirements - became the object of both analytical and experimental investigations.

A round robin test program in the US /1/ was already under way when the IEA program was defined. Moreover, the IEA round robin test - being international in scope - provided the unique chance of an adoption of test procedures by many countries based on common experience. The program initiated was not confined to a particular procedure but the NBS-method published in 1974 /2/ formed a basis to start with. A second procedure, the BSE-method /3/, came into being in the course of the program. These procedures subjected to amendments and supplemented by additional tests were applied to two collectors. Although the test program was initiated in 1977, some collector procurement problems resulted in delaying the tests by some participants until the summer of 1978.

A total of 16 laboratories were engaged in the test. The testing facilities were situated in 12 different countries distributed over the northern hemisphere.

The recommendations given, the conclusions drawn and the success of the round robin testing are the outcome of the contributions which were made readily available by all the experts in the working group.

This report is based on this excellent spirit of collaboration and the willingness to share experiences.

2. Collector performance

The performance of flat-plate collectors is investigated under conditions where essentially no heat is either released or stored by the structure and by the heat transfer medium in it (equilibrium conditions).

Effects of geometry can be neglected and the thermal conditions of the collector system ca be described by averaged temperatures /4/. The rate of energy extracted from the collector balances, the rate of radiative energy absorbed and of heat lost to a uniform environment. This state may be expressed as:

$$\frac{\dot{Q}_u}{A} = G \cdot (\tau\alpha)_e - U_L \, (T_p - T_a) \qquad (1)$$

$\dot{Q}_u$ = rate of useful energy extracted (W)
A = aperture area of collector (m^2)
G = solar irradiance, in the plane of the collector per unit area (W/m^2)
$(\tau\alpha)_e$ = effective transmittance - absortance product of the coverabsorber system
U_L = heat transfer loss coefficient for the collector ($W/m^2\ {}^oC$)
T_p = average temperature of the absorber surface of the collector (${}^oC$)
T_a = ambient air temperature (${}^oC$)

Since the plate temperature is difficult to access by measurements, at least by non-destructive test-emthods, it is convenient to relate the performance to the temperature of the fluid. It was shown by Duffie and Beckmann /5/ that either the inlet temperature or a mean temperature can be an appropriate reference temperature. This results in two equations:

$$\frac{\dot{Q}_u}{A} = F' \cdot G \cdot (\tau\alpha)_e - F' \cdot U_L \cdot (T_m - T_a) \qquad (2)$$

$$\frac{\dot{Q}_u}{A} = F_R \cdot G \cdot (\tau\alpha)_e - F_R \cdot U_L \cdot (T_i - T_a) \qquad (3)$$

F' = collector efficiency factor
F_R = collector heat removal factor
T_m = average temperature of fluid in the collector (arithmetic mean of inlet and outlet temperature for example)

T_i = inlet temperature of the fluid
T_o = outlet temperature of the fluid

Equation (3) is now a feature of the ASHRAE-method /6/, while equation (2) was specified in the NBS and BSE methods and was the agreed-on reference equation for the tests reported in the IEA program

These two equations are correlated by /5/:

$$F_R = F' \left(\frac{1-e^{-x}}{x}\right) \qquad x = \frac{U_L \cdot F' \cdot A}{m_f \cdot C_p} \tag{4}$$

m_f = mass flow rate of the fluid (kg/s)
C_p = specific heat of transfer fluid (J/kg·°C)

The collector efficiency is defined as the ratio of the useful energy extracted to the incident solar energy as follows:

$$\eta = \frac{\dot{Q}_u}{A\ G} = F' \cdot (\tau\alpha)_e - F' \cdot U_L \frac{(T_m - T_a)}{G} \tag{5}$$

$$\eta = \eta_o - U_o \frac{(T_m - T_a)}{G} \tag{6}$$

η_o = $F'\ (\tau\alpha)_e$, efficiency for $T_m = T_a$
U_o = $F'\ U_L$, global heat transfer coefficient (W/m^2 °C)

If values of η are plotted versus corresponding values of $(T_m - T_a)/G$ this will result in a curve with a negative slope U_o and intercept η_o.

Equation (6) forms the basis of the test procedures.

3. Collector Test Procedures

In the round robin test there were actually two procedure applied: the NBS method and the BSE method. A third procedure, the EIR method (Switzerland) was used by only one participant. It uses statistical long time measurements and is described in detail in Appendix A.

Common to all these test methods is the determination of the steady state efficiency of the collector. Due to inherently given changes in solar irradiance - even for clear sky conditions - it is rather a quasi-steady state that is investigated. To exclude time-dependencies, integration and averaging over the period of measurements is required.

This results in a straight forward definition of the efficiency η:

$$\eta = \frac{\int_{t_1}^{t_2} \dot{m}_f \cdot C_p \cdot (T_o - T_i)\, dt}{A \cdot \int_{t_1}^{t_2} G\, dt} \tag{7}$$

Although the procedures are applicable for collectors which use either a liquid or air as the transfer fluid, the IEA round robin test was confined to liquid heating collectors.

During the time of the round robin test, procedures were supplemented and changed. Additional tests were added: The NBS-method was modified with a procedure to determine the time constant of the collector and the influence of varying angles of incidence of radiation on the collector's surface. With these amendments - preserving the essence of the NBS method the procedure has been adopted as Standard 93-77 /6/ by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE). A similar development was recorded for the BSE procedure.

It should be noted that it was not necessary for laboratories to perform all parts of the test procedures but it was expected that the essential efficiency measurements would be made.

The NBS procedure is conducted with the collector exposed to solar radiation at all times (specifications for the use of a solar simulator are incorporated in ASHRAE 93-77) requiring a minimum irradiance of 630 W/m^2 and quasi-steady state conditions. This implies not too many suitable days of testing for places with less favourable weather conditions. Since collector efficiency is influenced by a number of environmental parameters, reproducibility of measurements is only given within a limited band.

The requirements concerning the mounting and the location, the test conduct, the accuracy and calibration of instrumentation are all specified in the procedure. The aim is to conduct the test under exposure conditions which will minimize the scatter.

During the test, a variety of steady-state conditions are monitored. The fluid inlet temperature is selected at four values over the range of interest. The average fluid temperature, the ambient temperature and solar irradiance are monitored, the efficiency is calculated at each temperature according to (7) resulting in a fitted efficiency curve. Ordinary flat-plate collectors show a performance that is close to linear with a slight tendency to quadratic curve.

The BSE procedure is a combined indoor-outdoor test thought to avoid the constraints mentioned above. While the efficiency at an operating temperature near ambient is measured outdoors, the heat losses of the collectors are determined indoors. From these data an efficiency curve is constructed. Reqriting (5) and (6) we obtain:

$$\frac{\dot{Q}_u}{A} = \eta_o \cdot G - U_o \cdot (T_m - T_a) \qquad (8)$$

and it becomes obvious that the expression $q_L = U_o \cdot (T_m - T_a)$ can be interpreted as a heat loss rate.

Two separate measurements are required:

η_o determination

The collector is run in a steady-state at a mean fluid temperature that is close to the ambient air temperature: the heat loss rate q_L tends to become zero and η_o can be determined.

$$\eta_o = \frac{\dot{Q}_u}{G\ A} \qquad (9)$$

Since it is not easy to meet the requirement $T_m = T_a$ exactly the BSE procedure provides for deviations up to 10 ^oC - with respective corrections:

q_L-determination

The collector is run indoor in a number of steady states (G = 0). The global heat transfer coefficient is determined as a function of the difference temperature $T_m - T_a$:

$$U_o = \frac{-\dot{Q}_u}{A\ (T_m - T_a)} \tag{10}$$

A linear least square fit is obtained as a function of $(T_m - T_a)$. The coefficients U_1, U_2 are determined.

$$U_o = U_1 + U_2 \cdot (T_m - T_a) \tag{11}$$

For any value of the parameter G the efficiency curve can be constructed:

$$\eta = \eta_o - U_1 \cdot \frac{(T_m - T_a)}{G} - U_2 \cdot \frac{(T_m - T_a)^2}{G} \tag{12}$$

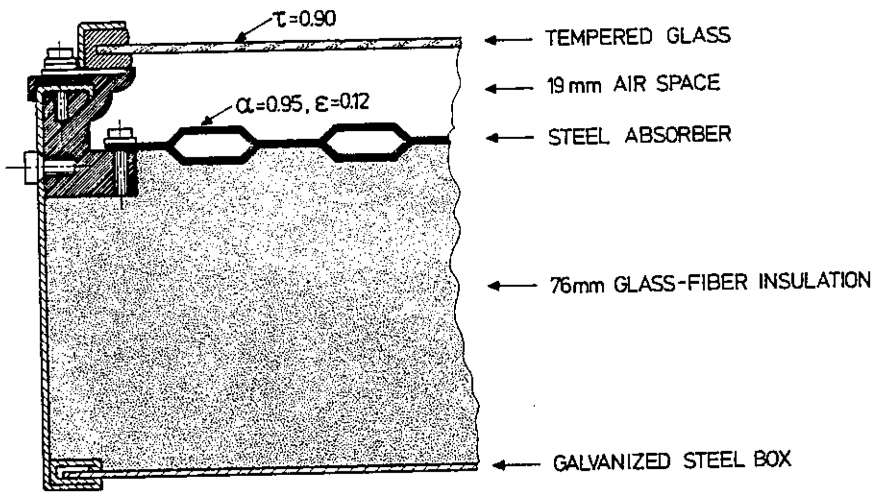
Special care is taken that a forced convection for air over the collector cover is maintained. The procedure requires the mounting of a fan.

Obviously the BSE procedure may be objectionable because a "laboratory efficiency" is determined with the collector not exposed to solar radiation, and it must be related to actual outdoor conditions.

4. Collectors in the Test

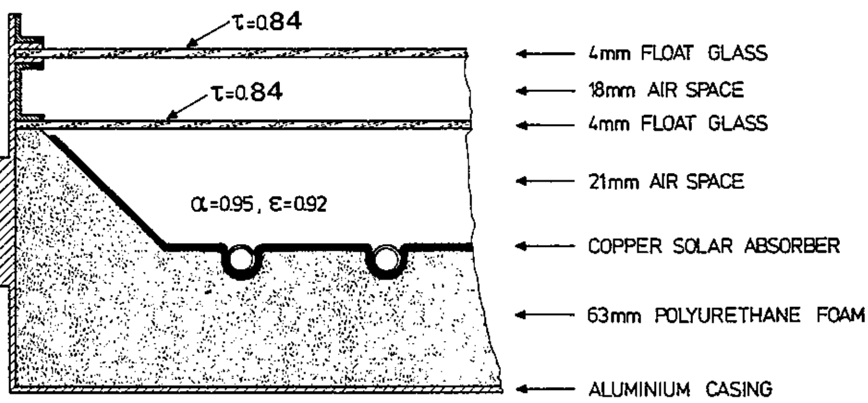
Two commercially available flat-plate liquid-heating collectors were chosen for the tests. A list of collector characteristics is given in Table 1, page 25. The types of collectors were agreed on to be single glass selective and double glass black paint. It was felt advantageous to copy the choices taken for the US /1/ and the CEC /10/ round robin tests.

The collector coded in this report as the IEA-1 collector had one tempered glass cover of high transmittance $\tau = 0.90$, the absorber plate was made from steel and was coated with a selective surface ($\alpha = 0.95$; $\varepsilon = 0.12$).



SCHEMATIC OF FLAT-PLATE COLLECTOR IEA-1

Figure 1



SCHEMATIC OF FLAT-PLATE COLLECTOR IEA-2

Figure 2

Thermal insulation is provided by the mounting block and layers of glass-fiber in the back. The collector box was roll formed and consisted of galvanized steel.

The collector coded in this report as the IEA-2 collector had two float glass covers of a single glass transmittance $\tau = 0.84$. The absorber foil and the tubes were made from copper. The absorber foil was wrapped around the tube covering 75 % of the tube area. The surface was coated with matt black polymerized paint (expected values: $\alpha = 0.95$; $\varepsilon = 0.92$). The absorber was backed by rigid foam polyurethane insulation. The whole system was housed in an aluminium casing.
A cross-sectional view of the two collectors is given in Figure 1 and 2.

It should be noted that it proved to be difficult to obtain a consistent set of collector parameters for one of the collectors. Even letters to the manufacturers could not clarify the situation. Quantities describing the collectors have, therefore, to be considered as the best choice.

5. Results and Analysis of Data

In conduct of the round robin test programs with the CEC and the IEA the need for a standard reporting format became obvious. A proposal on performance tests format sheets /8/ found general support and was jointly developed as a useful tool of round robin testing. The latest version of the format sheets are given in Appendix B.

The results for this round robin test were exclusively reported on this standard format. This eased the data handling a great deal. In correspondence with the number of collectors and procedures involved, there are four groups of data:

1. IEA-1 Collector, NBS-ASHRAE Procedure (Data given in Appendix C)
2. IEA-2 Collector, NBS-ASHRAE Procedure (Data given in Appendix D)
3. IEA-1 Collector, BSE Procedure (Data given in Appendix E)
4. IEA-2 Collector, BSE Procedure (Data given in Appendix F)

The results from one participant who used the EIR method sorted best with the BSE Procedure.

In a first step the data were subjected to a least square fitting to reassure a correct interpretation of the author's results. The format sheet required a fit according to

$$\eta = \eta_0 - a_1 \cdot T^* - a_2 \cdot (T^*)^2 \tag{13}$$

$$\text{with } T^* = U \frac{(T_m - T_a)}{I}$$

U normalizing coefficient = 10 $W/m^2\ ^oC$

Since the reference area (aperture area) determined and reported by the participants showed remarkable scatter. All data points were based to a common value: $A_{IEA-1} = 1.79\ m^2$; $A_{IEA-2} = 2.29\ m^2$.

It was left to the author to choose a linear, a square fit or both. This analysis skipped a square fit when it seemed not appropriate. The single glass collector IEA-1 tends to require a higher order fit while a linear fit is adequate for the IEA-2 collector.

This analysis yielded the intercepts, slopes or coefficients of the efficiency curves as listed in Table 3 to Table 6.

One participant reported values that showed a remarkable scatter, it was admitted that quasi-steady conditions were possibly not maintained, and the intercepts and slopes were regarded as "outlyers" and not used. The data from 10 facilities are shown in Figure 3 for the IEA-1 collectors, from 11 facilities in Figure 4 for the IEA-2 collectors.

It should be noted that the testing conditions with regard to type of fluid and mass flow rate selected by the participants were not as uniform as required by the standards.

The efficiency data for both collectors show a substantial scatter.While a certain amount of scatter is inherent in the procedures due to differences in environmental conditions as well as measurement errors, the question prevails whether the amount of scatter shown can be considered as representative for the procedure.

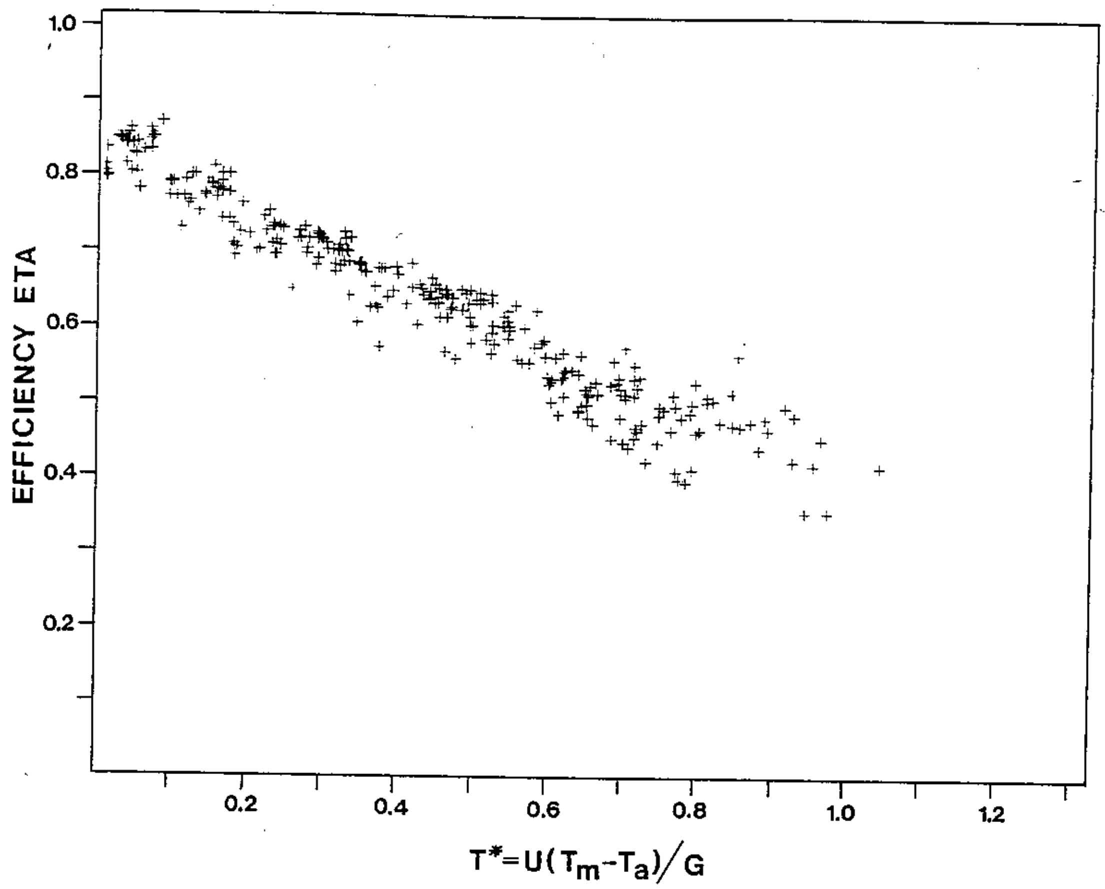


Figure 3: Efficiency data according to NBS/ASHRAE Procedure from 10 facilities, IEA-1 collector

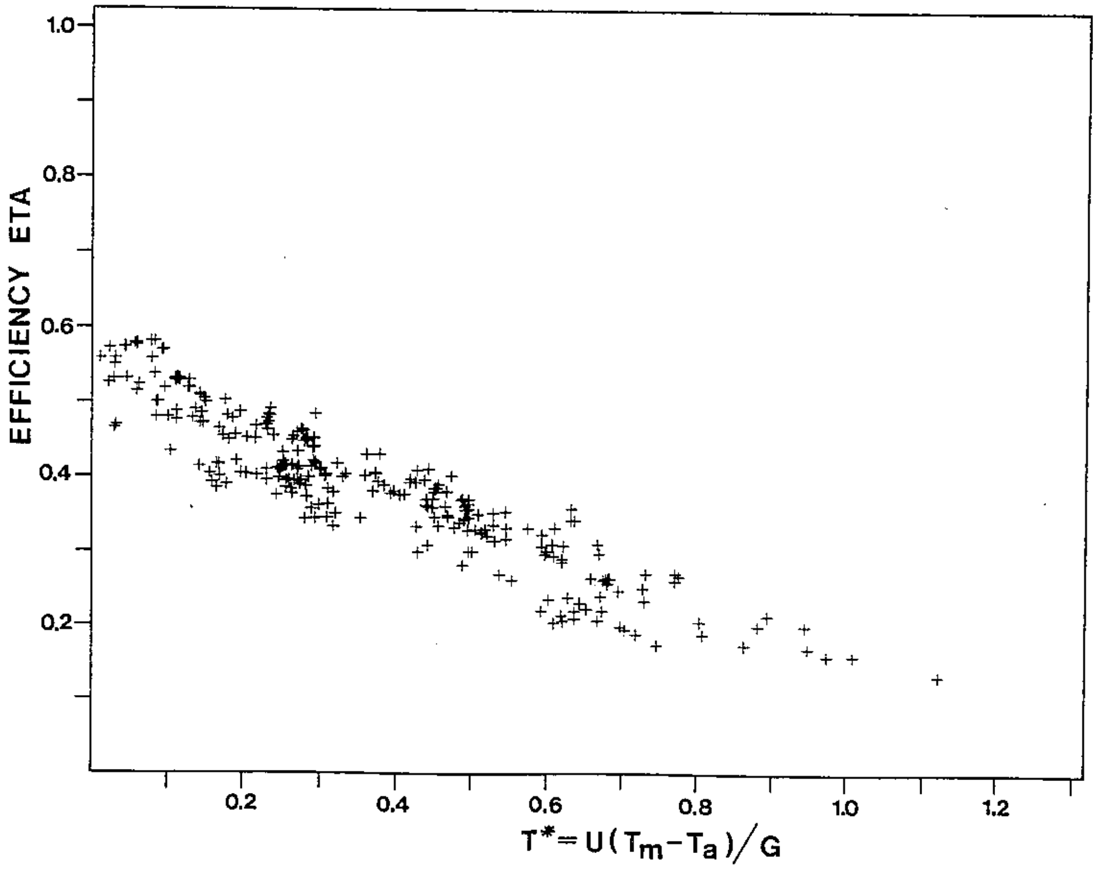


Figure 4: Efficiency data according to NBS/ASHRAE procedure from 11 facilities, IEA-2 collector

Pursuing this question a very rigid approach would be to correct each data point for deviation from an arbitrarily defined reference set of weather conditions based on a theoretical thermal performance collector model. The remaining scatter could be attributed to measurement errors; yielding at the same time the relative weights of both contributions /1/.

This kind of approach was considered as not feasible because the data base reported by the participants was not as complete as required for such an analysis, therefore an alternative approach was applied.

Step I: The efficiency data reported by the participants were evaluated to yield mean values of the intercepts and slopes for the efficiency curves of both collectors (Tables 3 to 6).

Step II: A theoretical collector model /7,15/ was applied to compute optical and thermal performance of the IEA-1 and IEA-2 collectors. This modelling is based on collector design parameters and an adjustment of edge and back loss coefficients resulting in verification of the mean values according to Table 3 and Table 4.

Modelling of the "optical efficiency"

As the collectors in the tests are of the flat-plate type, it is straigth forward to analyse the "optical efficiency" by theoretical models.

This was done in two ways:

I. A simple approximate method, Reference /5/,

II. The more involved net radiation method, Reference /7/.

The results according to both methods are compared in Table 2. It is concluded that the simple approximation method is adequate. If the computed effective absortance-transmittance product $(\tau\alpha)_e$ is compared with the mean η_0-values for both collectors, the collector efficiency factors F' can be determined:

$$\eta_0 = F' \, (\tau\alpha)_e$$

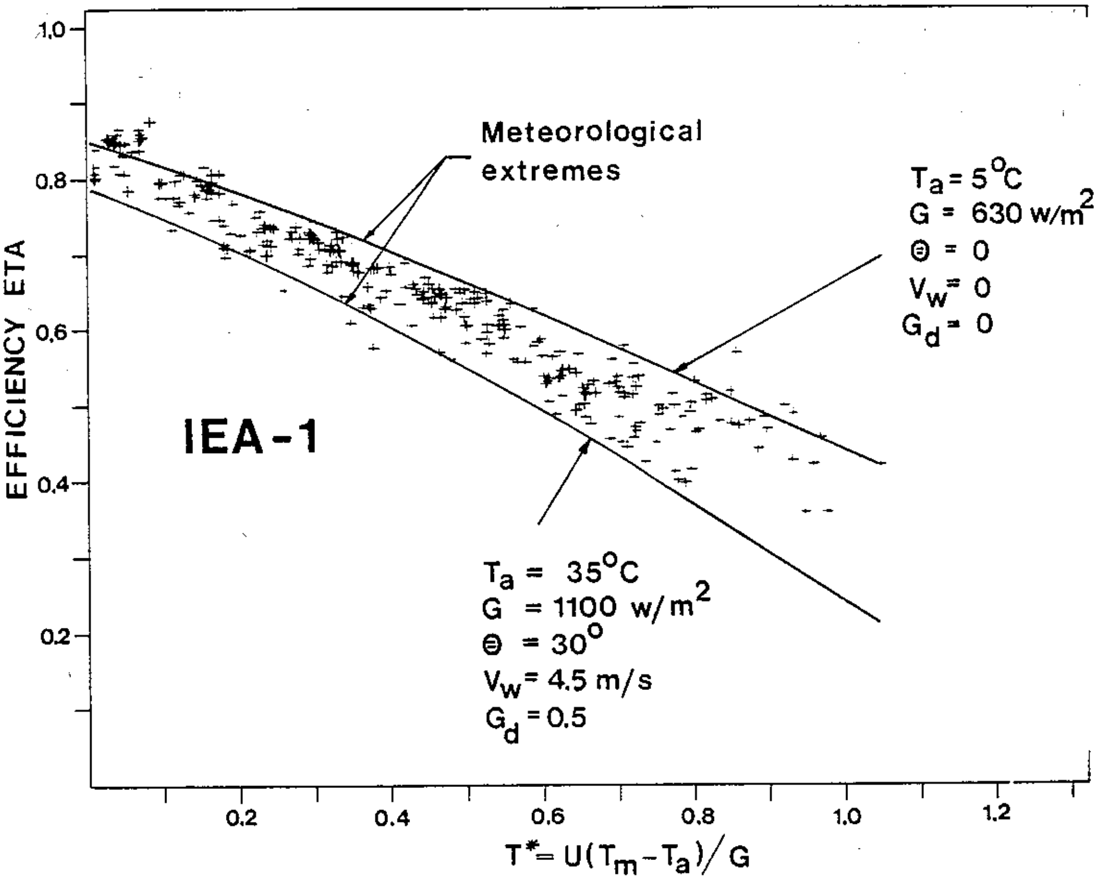


Figure 5: Data enclosed by extremes of collector performance

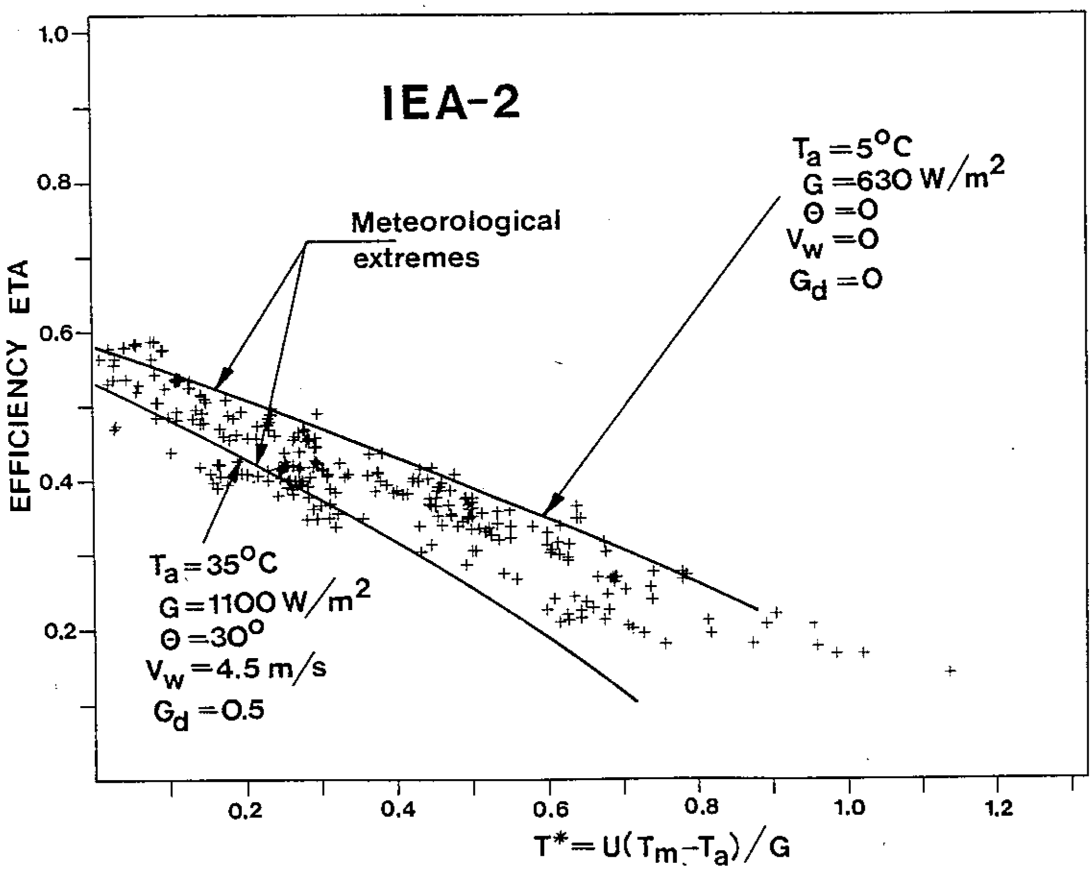


Figure 6: Data enclosed by extremes of collector performance

IEA-1 collector: $F' = \frac{0.83}{0.84} = 0.99$

IEA-2 collector: $F' = \frac{0.57}{0.754} = 0.75$

These efficiency factors were used for thermal performance modelling of the collectors. In addition, these factors are exceptionally indicative of the collector's heat transfer properties.

It should be noted that the $(\tau\alpha)_e$ product was evaluated for a set of parameters which are close to the true values. The solar absorptance and reflectance of the absorber plate was modelled as being isotropic.

Modelling of the thermal performance

The theoretical model given in reference /5/ was used to determine the front-loss coefficient for varying environmental conditions which are encountered during collector testing. Looking at the requirements of the ASHRAE-procedure two sets of environmental parameters can be identified which result into extremes of collector performance. These two sets which result either in high or in low collector efficiency are given by:

Low Efficiency	High Efficiency	
T_a = 35 °C	T_a = 5 °C	
G = 1100 W/m^2	G = 630 W/m^2	
θ = 30 °	θ = 0 °	
V_w = 4.5 m/s	V_w = 0.0 m/s	
G_d = 0.5	G_d = 0.0	(diffuse fraction)

Collector performance data enclosed by the two theoretical efficiency curves resulting from meteorological extremes allowed by ASHRAE standard 93-77 is shown in Figure 5 and Figure 6.

Step III:
Errors in measurements are another cause for the scatter of data shown in Figure 3 and 4. There are two kinds of measurement errors:

Random errors are shown to be rather small as can be seen from the small scatter found in the data for each facility. Participants are apparently able to obtain consistent measurements. Random errors are not addressed in this analysis.

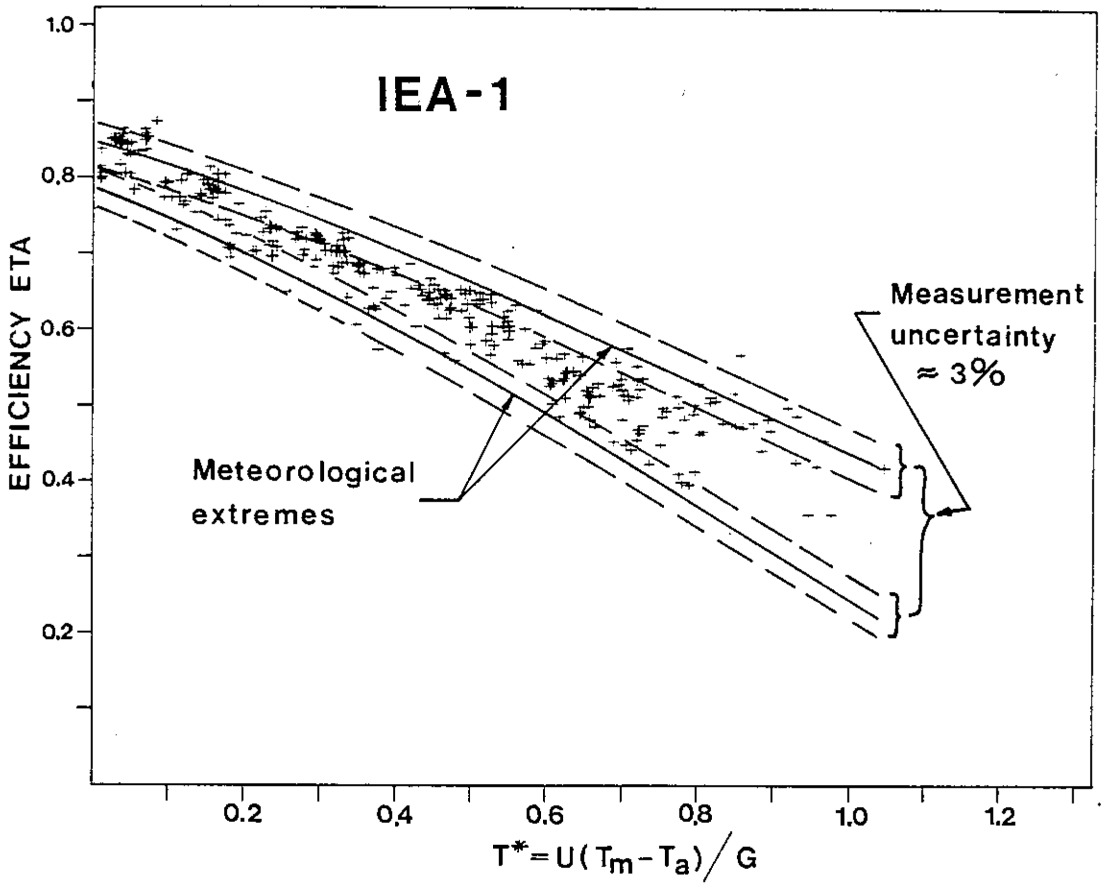


Figure 7: Data enclosed by the combined effect of meteorological extremes and measurement uncertainty

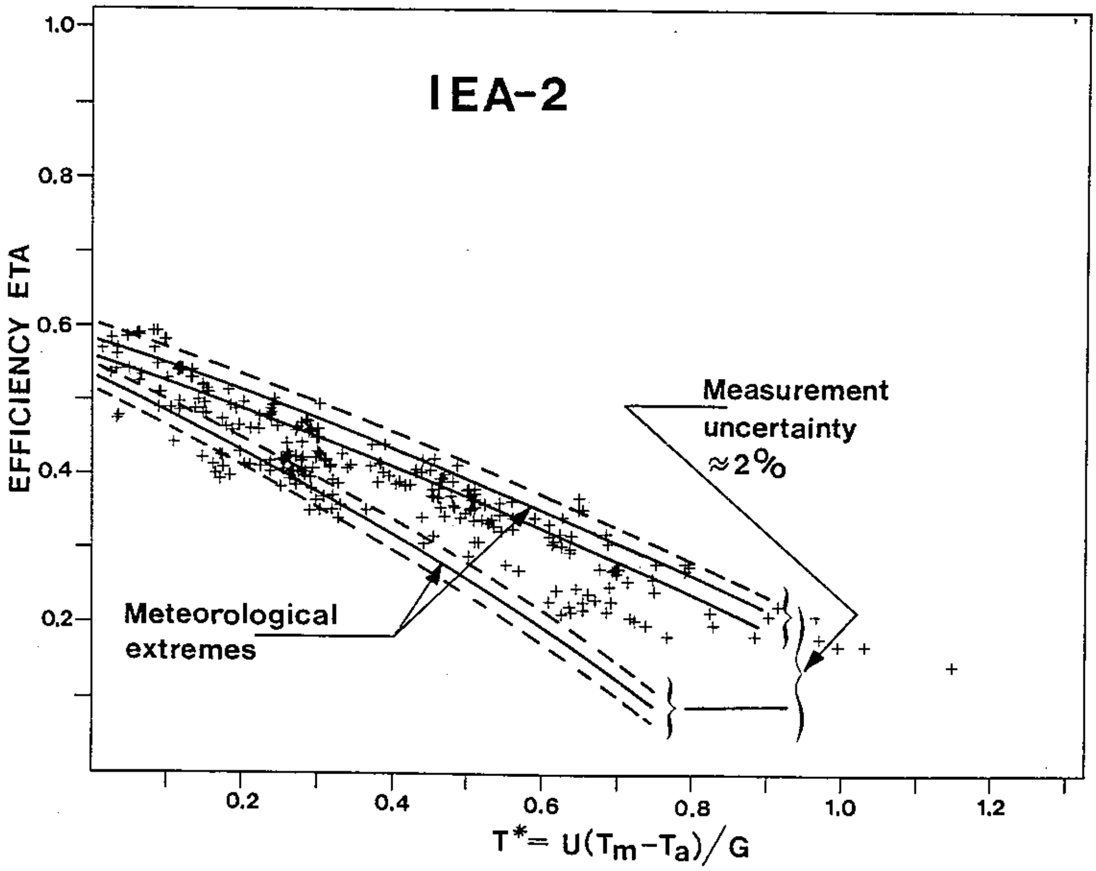


Figure 8: Data enclosed by the combined effect of meteorological extremes and measurement uncertainty

Systematic errors are peculier to testing facilities and are either positive or negative in sign. Systematic errors are determined by the requirements of the test procedures for the accuracy of instruments and calibrations.

While the results from a particular facility are biased by systematic errors, and are correctible in principle, the option for the analysis of round robin test results is confined to the assumption that the systematic errors of different test facilities are associated with a random uncertainty.

Based on the accuracy of the instrumentation as specified in the ASHRAE and BSE standards the following inaccuracies of measurements were assumed for the analysis:

$\frac{\Delta G}{G} = \pm 3\ \%$	solar irradiance
$\frac{\Delta \dot{m}}{\dot{m}} = \pm 1\ \%$	mass flow rate
$\Delta(\Delta T) = \pm 0.1\ ^{o}C$	difference temperature
$\Delta(T) = \pm 0.5\ ^{o}C$	absolute temperature

The inaccuracies of measurements were assumed to propagate into an uncertainty $\pm \Delta\eta$ and $\pm \Delta T^{*}$ of the efficiency curves according to the root-mean-square error propagation. This kind of analysis yields an error band which is essentially parallel to the efficiency curve.

Figure 7 and Figure 8 show the data for both collectors bracketed by calculated efficiency curves for extreme environmental effects, and with the measurement uncertainty of systematic errors.

The essence of the analytical approach could be termed as follows:

1) The combined effect of environmental conditions and systematic errors on efficiency measurements could in principle explain the data scatter observed in round robin testing.
   Since the extreme meteorological conditions are by no means representative for the actual test conditions met by the participants, one should expect a very prominent grouping of data points around the mean values. This is shown to some extent for the IEA-1 collector, but not apparent for the IEA-2 collector.

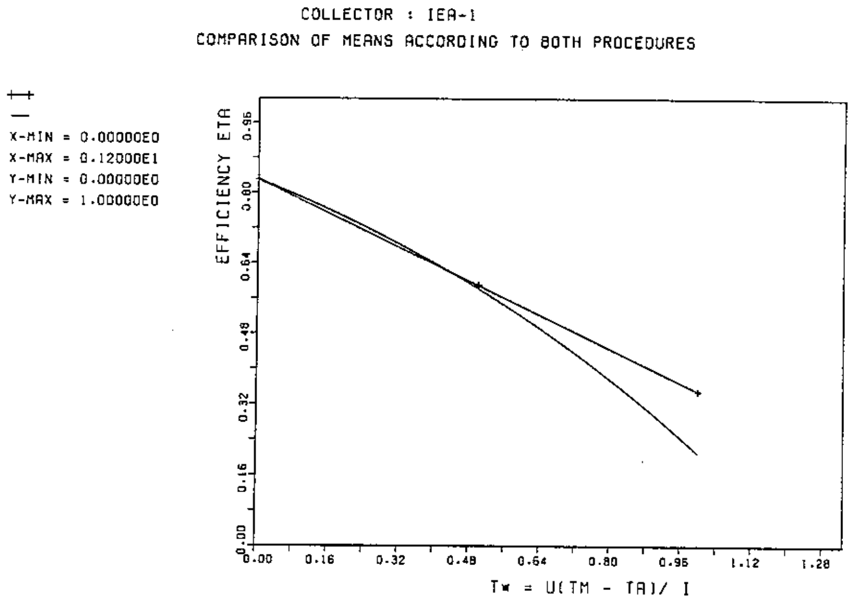


Figure 9: Comparison of efficiency according to both procedures;
IEA-1 collector
NBS-Procedure (linear fit)
BSE-Procedure (higher order fit)

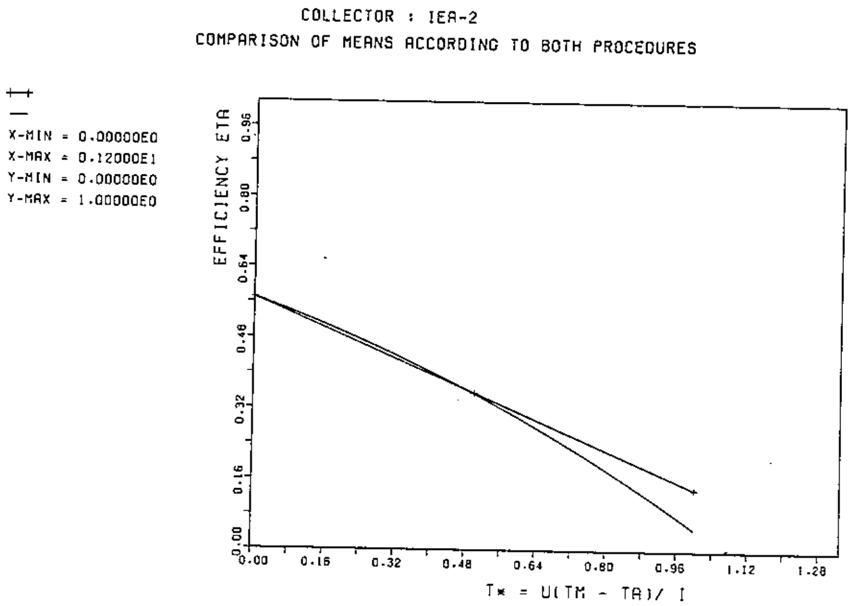


Figure 10: Comparison of efficiency according to both procedures;
IEA-2 collector
NBS-Procedure (linear fit)
BSE-Procedure (higher order fit)

2) The computed efficiency curves verify that the environmental impact tends to be small for small temperature differences (T_m - T_a). The slope of the curves is predominantly effected by the wind speed resulting in a considerable spread at higher operating temperatures for the collectors.

This has to be seen in connection with the important result from the error analysis that the finite instruments' accuracies which cause a systematic error in measurement have a negligible effect on the slope of the efficiency curve. This is true as long as the dominant uncertainty is associated with the inaccuracy of the irradiance measurement. The data scatter found near the η_0-intercept can therefore be taken as a quantitative measure for systematic errors of the different test facilities.

Since the data scatter found for the IEA-2 collector is insufficiently covered by the analytical efficiency curves, the effect of fabrication induced scatter cannot be excluded. This is consistent with indications from a number of participants that the thermal contact between tube and absorber sheet for collector IEA-2 could not inherently guarantee stable thermal properties for different specimens.

The results derived from application of the BSE-procedure were expected to be less affected from an environmental impact on the slope and to show only small scatter. This is contrary to the experimental evidence: the scatter is not less than for the outdoor measurement.

It is probable that systematic errors do account for the scatter. The heat loss coefficient proved to be a rather sensitive parameter as can be seen from the scatter reported by individual participants. Constructing the efficiency curve, the uncertainties are smoothed out partly because of a kind of integration process. Indoor measurements have their own "environment" and are difficult to control when natural convection is applied.

The BSE procedure requires a wind speed of 5 m/s over the collector for those data points that are used for the construction of the efficiency curve. Since not all of the participants followed this rule, the statistics for mean values is not very complete.

It is of some interest to compare efficiency curves derived from both of the two procedures. The mean efficiency curves according to NBS/ASHRAE and BSE are compared in Figure 9 and Figure 10. The measurements for both procedures are not independent with regard to the intercept η_0. Although this comparison is of limited relevance as far as the physics of an indoor and outdoor correlation are concerned, the emperical result shows a remarkable agreement for the efficiency curves of both collectors.

6. Conclusions and Recommendations

The scatter of data of the efficiency curves is in the "traditional" range obtained from round robin tests.

The analysis has given an indication that systematic test uncertainties of the testing facilities are a key reason for the scatter of measured collector efficiencies.

Apart from the analysis conducted, participants have expressed their concern about the uncertainty associated with the accuracy of the pyranometers. The Participants had difficulties to ascertain the nominal accuracy of ± 3 % for their pyranometers.

Both procedures have been shown to be applicable and useful for determining collector thermal performance. Neither of the two procedures proved to be superior with respect to small data scatter. The mean curves according to both procedures do compare well. Moreover, physically more meaningful, the curves for both procedures taken at a particular facility do compare very well.

The recommendations given are supported not only by the conclusions derived from the formal analysis but also by participants' views and experience gained independently from round robin testing.

Experimentalists should give great care to the calibrations of their testing facility.

The experimentalists should employ a comprehensive in-situ calibration of the testing facility. A calorimetric calibration is recommended.

International pyranometer standards and calibration methods are needed to provide the individual test facilities with an instrument of known accuracy and precision for collector test purposes.

The calibration procedure for pyranometers should include performance under tilted positions.

The indoor environment and the stepwise procedure of taking data according to the BSE standard over a range of temperatures should be observed carefully.

Application of forced convection by a fan system during outdoor testing could help to reproduce testing condition wth respect to wind speed.

The standard procedures evaluated in this round robin test are intended to be generally applicable. However, the results derived from flat-plate collector testing have to be considered as selective. It is felt that further comparative testing is required to validate the usefulness of the procedures for other types of collectors.

It is felt necessary that the procedure should provide efficiency data supplemeted by confidence limits.

This is not apparent from the data. It is possible that wind effects over the top surface of the collector may differ from these measured adjacent to the collector and that wind screens and fans may be desirable to provide reproducible testing conditions outdoors.

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Table 1 Collector characteristics and parameters (from manufacturer's literature and from [1])

Characteristics	Collector IEA-1	Collector IEA-2
Manufacturer	Chamberlain Mfg. Co Elmhurst, Illinois USA	Commercial Solar Energy Nottingham, England
Gross dimensions (m)	2.14 x 0.92	2.00 x 1.22
Aperture dimensions (m)	2.08 x 0.86	1.94 x 1.18
Aperture Area (m^2)	1.79	2.29
Cover plate assembly		
Number of glass plates	1	2
Thickness (mm)	3.2	4.0
Material	low-iron tempered glass	float glass
Solar transmittance	0.90	0.84 (each)
I. R. emittance	0.88	0.84
Absorber plate		
Material	Mild steel	Copper
Plate construction	Stich welded	10 parallel tubes
Tube spacing (m)	-	0.112
Coating	Black Chrome	Matt black paint
Solar absorptance	0.95	0.95
Solar emittance	0.12	0.92
Air Spaces (mm)		
Between covers	-	18.0
Between cover and absorber	19.0	21.0
Insulation		
Material	glass-fiber	Polyurethane
Density (kg/m^3)	80.	50.
Thickness (mm)	76.2	50.
Thermal conductivity ($W/m \cdot {}^oK$)	0.03	0.024

Table 2

Optical Properties

	FLAT-PLATE COLLECTOR			
	IEA 1		IEA 2	
Index of Refraction	1.51		1.526	
Thickness of pane I	3.2 mm		4 mm	
Thickness of pane II	–		4 mm	
Extinctions Coefficient	0.1 cm^{-1}		0.125 cm^{-1}	
Solar absorptance α	0.94		0.95	
I.R. emittance ε	0.14		0.95	
Assumptions: **diffuse adsorber** **diffuse light is isotropically distributed**	Theorectical model A: Net radiation method [5] B: Approximate method [6]			
	A	B	A	B
Cover system				
Transmittance	0.892	0.891	0.765	0.766
Reflectance	0.077	0.079	0.140	0.139
Absorption	0.031	0.030	0.095	0.095
(normal incidence)				
Cover system		60°appr.		60°appr.
Transmittance	0.818	0.814	0.678	0.672
Reflectance	0.147	0.148	0.216	0.219
Adsorption	0.035	0.038	0.106	0.109
(100 % diffuse light)				
Cover system + absorber				
Reflectance	0.121	–	0.162	–
Absorption (panes)	0.033	–	0.099	–
Absorptance	0.846	0.845	0.735	0.736
(normal incidence)				
Cover system + absorber				
Reflectance	0.188	–	0.241	–
Adsorption (panes)	0.037	–	0.109	–
Absorptance	0.775	0.771	0.650	0.645
(100 % diffuse light)				
(15 % diffuse) $\tau\alpha$ =	0.835	0.834	0.722	0.722
(15 % diffuse) $(\tau\alpha)_e$ =	0.839	0.838	0.754	0.757

Table 3

Summary of Collector Thermal Performance
Collector: IEA-1; Procedure: NBS

Participant	Linear Curve				$\eta = \eta_o - a_1 \cdot T^* - a_2 \cdot (T^*)^2$					Pyranometer modell
	η_o	$\Delta\eta_o$	a_1	Δa_1	η_o	$\Delta\eta_o$	a_1	a_2	Area	
A	0.73	– 12 %	0.37	– 23 %	–		–	–	1.79	Kipp + Zonen CM 5
CDN	0.84	2 %	0.47	– 3 %	0.83	1 %	0.42	0.06	1.79	Eppley 8-48
D Jülich	0.82	– 2 %	0.48	0 %	0.80	– 3 %	0.36	0.13	1.79	Kipp + Zonen CM 5
D Heidelberg	0.84	2 %	0.44	– 9 %	–		–	–	1.79	Eppley
D Stuttgart	0.84	2 %	0.42	– 13 %	–		–	–	1.79	Kipp + Zonen CM 6
DK	0.87	5 %	0.59	22 %	0.86	4 %	0.49	0.13	1.79	Kipp + Zonen CM 5
GB	0.81	– 3 %	0.41	– 15 %	–		–	–	1.79	Kipp + Zonen
J	0.83	0 %	0.52	8 %	0.81	– 2 %	0.37	0.19	1.79	EKO – MS 41
NL	0.77	– 7 %	0.45	– 7 %	–		–	–	1.79	Kipp + Zonen
S	0.81	– 3 %	0.52	– 8 %	0.80	– 3 %	0.35	0.24	1.70	Eppley
USA NBS	0.83	0 %	0.44	9 %	–		–	–	1.79	Eppley PSP
USA Phoe.	0.87	5 %	0.55	– 15 %	0.85	3 %	0.39	0.20	1.79	–
Mean $\bar{\eta}_o$	0.83		0.48		0.825					
Standard Deviation σ	±.03		±.06		±.025					

Table 4

Summary of Collector Thermal Performance
Collector: IEA-2; Procedure: NBS

Participant	Linear Curve				$\eta = \eta_o - a_1 \cdot T^* - a_2 \cdot (T^*)^2$					Pyranometer modell
	η_o	$\Delta\eta_o$	a_1	Δa_1	η_o	$\Delta\eta_o$	a_1	a_2	Area	
A	0.47	− 22 %	0.22	− 50 %	–	–	–	–	2.29	Kipp + Zonen CM 5
B Heverlee	0.59	3 %	0.50	15 %	0.53	− 6 %	0.13	0.50	2.29	Kipp + Zonen CM 5
B Mons	0.66	+ 15 %	0.60	38 %	0.61	8 %	0.29	0.35	2.29	Eppley 4-48
D Jülich	0.57	0 %	0.41	− 6 %	0.58	3 %	0.43	−0.02	2.29	Kipp + Zonen CM 5
D Heidelberg	0.54	− 6 %	0.41	− 6 %	0.52	− 8 %	0.20	0.16	2.29	Eppley
D Stuttgart	0.60	5 %	0.51	18 %	0.61	8 %	0.52	0.00	2.20	Kipp + Zonen CM 6
E	0.56	− 3 %	0.37	− 15 %	0.55	− 2 %	0.35	0.02	2.29	Eppley
GB	0.55	− 4 %	0.37	− 15 %	0.56	1 %	0.41	−0.03	2.29	Kipp + Zonen
J	0.59	3 %	0.46	6 %	0.56	1 %	0.27	0.21	2.29	EKO – MS 41
NL	0.57	0 %	0.41	− 6 %	0.57	1 %	0.44	−0.06	2.29	Kipp + Zonen
S	0.58	1 %	0.48	11 %	0.53	− 6 %	0.10	0.56	2.29	Eppley
US NBS	0.58	1 %	0.47	9 %	0.58	3 %	0.47	0.00	2.29	Eppley PSP
Mean $\bar{\eta}_o$	0.57		0.43		0.56					
Standard Deviation σ	±0.05		±0.094		±0.03					

Table 5

Summary of Collector Thermal Performance
Collector: IEA-1; Procedure: BSE

Participant	**Efficiency** $\eta = \eta_o - a_1 \cdot T^* - a_2 \cdot (T^*)^2 \cdot I$ [I]=kW				**Heat Transfer Coefficient** $U_m = U_o + U_1$ (Tm-Ta); ($W/m^2 \cdot °C$)					**Pyranometer modell**
	ηo	$\Delta\eta_o$	a_1	a_2	U_o	ΔU_o	U_1	ΔU_1	wind	
CH*	0.85	2 %	0.33	0.00	3.27	– 12 %	0.000	const.	1 m/s	–
D Jülich	0.81	– 3 %	0.35	0.30	3.50	– 6 %	0.003	18 %	5 m/s	Kipp + Zonen CM 5
D Heidelberg	0.86	4 %	0.43	0.22	4.30	16 %	0.022	– 15 %	5 m/s	Eppley
DK	0.86	4 %	0.36	0.23	3.60	– 3 %	0.023	– 10 %	5 m/s	Kipp + Zonen CM 5
GB	0.84	1 %	0.42	0.04	4.20	13 %	0.004	const.	0 m/s	Kipp + Zonen
NL	0.77	– 8 %	0.37	0.23	3.65	– 1 %	0.023	– 10 %	5 m/s	Kipp + Zonen
J**	0.83	0 %	0.40	0.16	4.03	9 %	0.016	– 37 %	2 m/s	EKO – MS 41
USA	0.83	0 %	0.35	0.29	3.45	– 7 %	0.029	14 %	5 m/s	Eppley PSP
Mean $\bar{\eta}_o$	0.83				3.70		0.025 (for 5 m/s + BSE-method)			
Standard σ	±0.03				±0.35		±0.004			

* According to the EIR-method
** Losses measured outdoors

Table 6

Summary of Collector Thermal Performance
Collector: IEA-2; Procedure: BSE

Participant	Efficiency $\eta = \eta_o - a_1 \cdot T^* - a_2 \cdot (T^*) \cdot {}^2I$ [I]=kW				Heat Transfer Coefficient $U_m = U_o + U_1$ (Tm-Ta); ($W/m^2 \cdot °C$)					Pyranometer modell
	ηo	$\Delta\eta_o$	a_1	a_2	U_o	ΔU_o	U_1	ΔU_1	wind	
B	0.61	7 %	0.37	0.30	3.68	5 %	0.03	– 70 %	0 m/s	Kipp + Zonen CM 5
CH*	0.52	– 9 %	0.36	0.00	3.61	3 %	0.00	const.	3 m/s	
D Jülich	0.56	– 2 %	0.31	0.13	3.13	– 11 %	0.01	– 25 %	3 m/s	Kipp + Zonen CM 5
D Heidelberg	0.51	– 11 %	0.30	0.12	2.99	– 15 %	0.01	– 30 %	0 m/s	Eppley
DK	0.63	10 %	0.37	0.17	3.66	5 %	0.02	0 %	5 m/s	Kipp + Zonen CM 5
E**	0.55	– 4 %	0.36	0.01	3.62	4 %	0.00	const.	0 m/s	Eppley
GB	0.55	– 4 %	040	0.04	4.04	16 %	0.00	const.	0 m/s	Kipp + Zonen
J**	0.56	– 2 %	0.28	0.18	2.79	– 20 %	0.02	4 %	0 m/s	EKO – MS 41
NL	0.56	– 2 %	0.32	0.19	3.22	– 8 %	0.02	10 %	5 m/s	Kipp + Zonen
USA NBS	0.58	2 %	0.32	0.12	3.25	– 7 %	0.01	– 30 %	8 m/s	Eppley
Mean $\bar{\eta}_o$	0.57				3.49		0.017			
Standard Deviation σ	±0.04				±0.36		±.006			

* According to the EIR-method
** Losses measured outdoors

APPENDIX A

The EIR method for collector testing
(Text by P. Kesselring, J.M. Suter)

The EIR method for collector testing

Testing hot water collectors under Swiss meteorological conditions is a hard job, as the clear sky required e.g. by ASHRAE or NBS procedures exists only on a few days a year. Therefore, from the very beginning we tried at EIR to aim at a method suitable for outdoor testing of collectors under covered sky conditions. The method described in the following fulfills this requirement and is able to provide the same parameters as the NBS or BSE procedures.

The evaluation principle

The evaluation principle has some similarity with the BSE (former ASE) procedure: η_0 is also determined around solar noon under clear sky condition and $T^* \simeq 0$ by extrapolation of measured points to $T^* = 0$. The difference lies in the determination of thermal losses. These are measured outdoor under 100 % diffuse radiation condition.

Measurement of thermal loss factor

The situation of stable 100 % diffuse radiation - e.g. covered sky, fog or early morning hours - is often characterized by slowly varying ambient temperature and low absolute values of radiation (100 - 300 W/m^2). We then have a case, where the thermal losses of a collector are very nearly stationary. At the same time, the incident radiation may change by an order of magnitude in intensity, although the angular distribution remains constant - e.g. isotropic. Under these conditions T^* may easily vary by a factor of 10 with a corresponding change in the efficiencies. If the mean collector temperature lies only slightly above ambient temperature, then η-values from e.g. -1 (radiation losses ≈ irradiated energy) to nearly η_0 may occur. As the thermal losses are very early constant, the η vs. T^* plot is very nearly linear, its slope giving the low temperature heat loss factor a_1. The η-axis intercept gives a value of the optical efficiency for diffuse radiation. We call it η_{oD}.

Increasing the mean collector temperature, the same procedure gives values for the high temperature loss factor. As the values are lying in the high

T^*-value range - η being usually always negative - no reliable extrapolation to $T^* = 0$ can be made. This means that although the slope values are quite satisfactory, the η-axis intercept are of no value in this case.

η_o-Determination

In measuring η_o another difficulty arises. We remember that here the radia- should be of normal incidence to the collectors. However, in our climate it often happens, that under clear sky conditions the amount of diffuse light is up to 30 %. Because of the modified angular distribution of the incident light the measured η_o-values will be systematically low, since they should be determined at 100 % direct insolation.

Using the values η_{oD}, determined under completely diffuse radiation conditions, we can calculate an upper limit for η_o. We assume that the diffuse part d of the radiation may be used with efficiency η_{oD}, the percentage (1-d) with efficiency η_o to give then the measured efficiency η_{oG} for the actual global radiation.

(0) $$d\eta_{oD} + (1-d)\eta_o = \eta_{oG}$$

(1) $$\eta_o = \frac{\eta_{oG} - d\eta_{oD}}{(1-d)}$$

This value will be systematically high, as the actual diffuse radiation under clear sky conditions is mostly circumsolar, whereas the η_{oD} was determined at rather isotropic radiation conditions.

Construction of the clear sky collector characteristic

The IEA form of the stationary collector equation is

(2) $$\eta = \eta_o - a_1 T^* - a_2 T^{*2}$$ (see page 13, eq. 13)

As mentioned above the η_o value is a clear sky value determined in a BSE like way. From measurements as described we get a thermal loss factor function $K = K\ (T_m,\ T_a)$ which can be approximated

(3) $K = \alpha + \beta\,(T_m - T_a)$

where α is the low temperature loss factor. Comparing this with (2) and eq. 13 (page 13), we have

(4) $a_1 = \alpha/U_o$ (5) $a_2 = \frac{\beta \cdot G}{U_o{}^2}$

Remains the question, what value of G in equation (5) should be used. As the NBS rules to determine (2) require high irradiation conditions, it is clear that e.g. a value of $G = 900\ W/m^2$ is appropriate.

Test performed on the IEA collectors

Experiments under diffuse radiation conditions

Tests are conducted on the automatic test facility of the Swiss Federal Institute for Reactor Research (EIR). About 40 runs similar to that documented on pages A 62,A 77 for August 14, 1979, have been performed for both IEA collectors. Taking a statistical mean of the collector parameters leads to the value given below.

In checking the data set in page A 61, A 62 it should be noted that a mass-flow correction of + 6 % has been applied in computing the ETA values. This takes into account the results of manual calibrating (bucket and watch method) of the computer operated flow meter, which is the source of the values in the tables. The correction factor is checked every few days.

η_{oG}-Measurements

The data given on page A 61,A 76 contain the results of a clear day experiment on July 30, 1978. The same flow value correction as above applies also in this case.

In comparing the η_{oG} values with the mean values below, it is important to remember the definitions for the different parameters η_{oD}, η_{oG}, and η_o given by eq. (0) (page A3).

The mean values for η_o below result from experiments on 17 different days.

Mean values of collector parameters

Results of parameter measurements with diffuse radiation scatter around mean values because meteorological "boundary conditions" vary in a manner, very difficult to identify. However, statistical mean values over many experiments are reproducible to less than 2 %. The following table gives the collector parameters as computed from the above mentioned data set.

Collector	η_{oD}		a_1		η_o	$\eta_o(0.2)$
IEA 1	0.73	0.01	0.33	0.01	0.89	0.86
IEA 2	0.50	0.01	0.34	0.01	0.58	0.56

The errors given are standard deviations from the η_{oD}, a_1 values measured in the above mentioned set of experiments.

The experience of the last two years shows that e.g. the standard deviation σ_{oD} of the η_{oD} mean values as a fuction of the numbers of experiments m, conducted on different days, follows quite well the law $\sigma_{oD} = 0.06/\sqrt{m}$.

So far no a_2 values for the IEA collectors have been measured.

With $\eta(0.02)$ we denote the η_o values for 20 % diffuse radiation. It is this $\eta(0.20)$ value that should be compared to ASHRAE or BSE values. By the way, the ratio $\eta_o/\eta_{oD} \approx 1.17$ is about as expected theoretically on the basis of purely direct and completely isotropic radiation.

APPENDIX B

IEA/CEC Round Robin Testing Format Sheets

IEA SOLAR COLLECTOR TESTING PROGRAMME
FORMAT SHEET

Ref. ....

TESTS PERFORMED BY : ....

.... Tel. ....

.... Telex ....

1. Description of Solar Collector

1.1 NAME OF COLLECTOR AND MANUFACTURER : ....

....

1.2 TRANSPARENT COVERS

– Number .... Thickness .... mm

– Material ....

– Aperture dimensions ....

1.3 ABSORBER PLATE

– Material ....

– Surface treatment ....

– Manufacturing process ....

– Weight empty .... Kg Water content .... Kg

– Dimensions ....

....

1.4 THERMAL INSULATIONS AND CASING

– **Thermal insulation:** Thickness .... cm

– Material ....

– **Casing:** Material ....

– Total weight of collector with water .... Kg

– Gross dimensions ....

1.5 LIMITATIONS

- Maximum temperature of operation ....

- Maximum pressure ....

- Acceptable heat transfer fluids ....

....

1.6 SCHEMA OF SOLAR COLLECTOR

2. Instantaneous Efficiency Test

2.1 METHOD ....

....

2.2 SCHEMA OF TEST INSTALLATION

2.3 INSTRUMENTATION ....

- Incident radiation ....
- Diffuse radiation ....
- Fluid mass flow ....
- Ambient temperature ....
- Fluid absolute temperature ....
- Differential fluid temperature ....
- Wind velocity ....
- Data recording ....
- Pressure drop transducers ....

2.4 PHOTO OF SOLAR COLLECTOR TEST RIG

3. Instantaneous Efficiency Curve

THE INSTANTANEOUS EFFICIENCY η IS DEFINED BY : $\eta = \frac{q_u}{A \cdot I}$

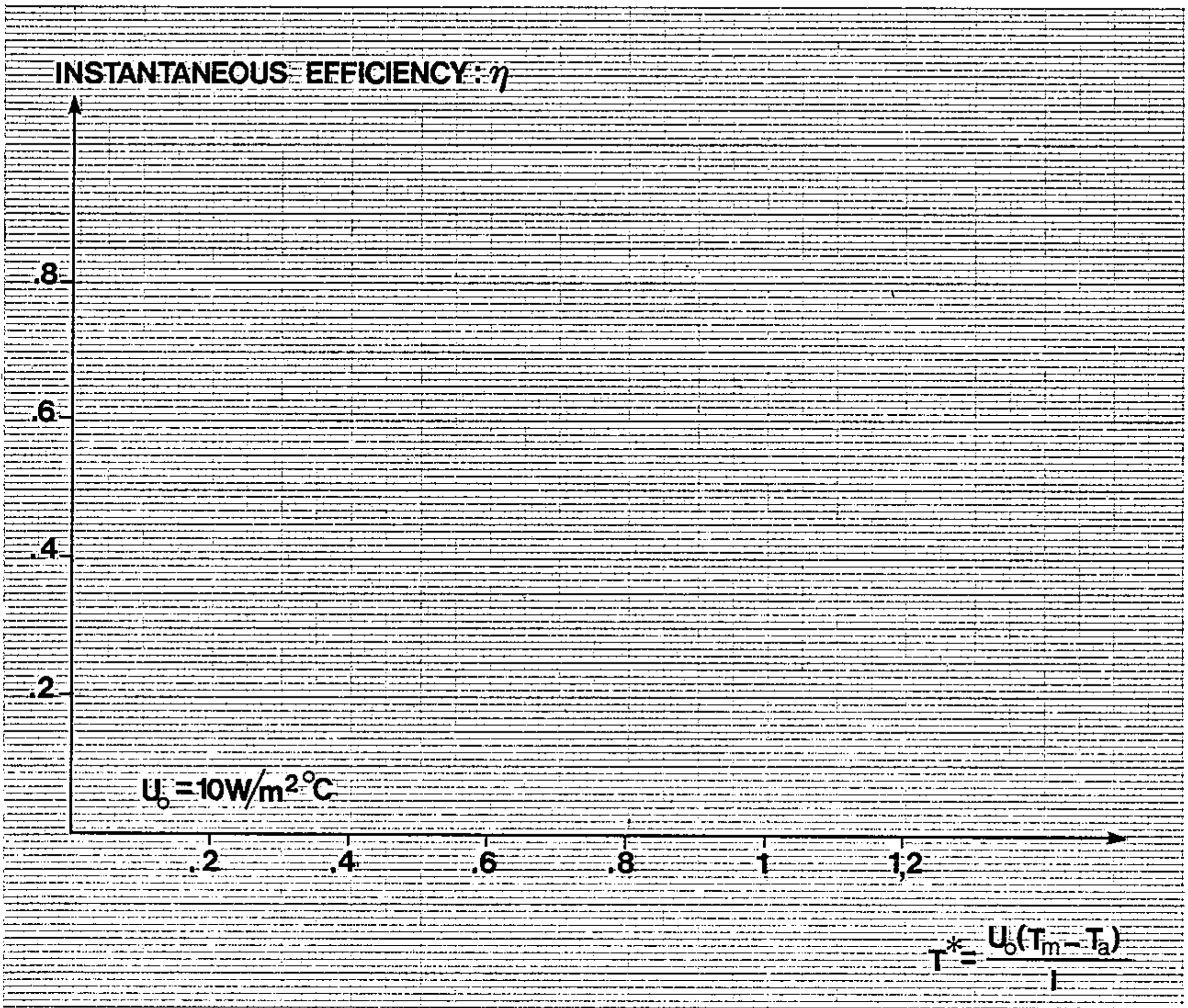
q_u : useful power extracted (W)

I : incident radiation (W/m^2)

A : reference area (m^2)

Specify reference area used for curve

- ☐ gross area of collector
- ☐ aperture area
- ☐ absorber area



RECOMMENDED EQUATION : $\eta = \eta_0 - a_1 \; T^* - a_2 \; (T^*)^2$

η =

4. Instantaneous Efficiency : Experimental Data

LATITUDE ....

LONGITUDE ....

AZIMUTH ....

FLUID : .... Cp .... SLOPE : .... HOUR AT SOLAR NOON ....

D	hr	I	I_d/I	m_f	T_a	T_i	ΔT	T_m	T*	η	V	

REFERENCE AREA : .... m^2 HEAT CAPACITY : .... KJ/°C

(AZIMUTH refers to collector position)

4. Instantaneous Efficiency : Experimental Data

LATITUDE ....

LONGITUDE ....

AZIMUTH ....

FLUID : .... Cp .... SLOPE : .... HOUR AT SOLAR NOON ....

D	hr	I	I_d/I	m_f	T_a	T_i	ΔT	T_m	T*	η	V	

REFERENCE AREA : .... m^2 HEAT CAPACITY : .... KJ/°C

(AZIMUTH refers to collector position)

4. Instantaneous Efficiency : Experimental Data

LATITUDE ....

LONGITUDE ....

AZIMUTH ....

FLUID : .... Cp .... SLOPE : .... HOUR AT SOLAR NOON ....

D	hr	I	I_d/I	m_f	T_a	T_i	ΔT	T_m	T^*	η	V	

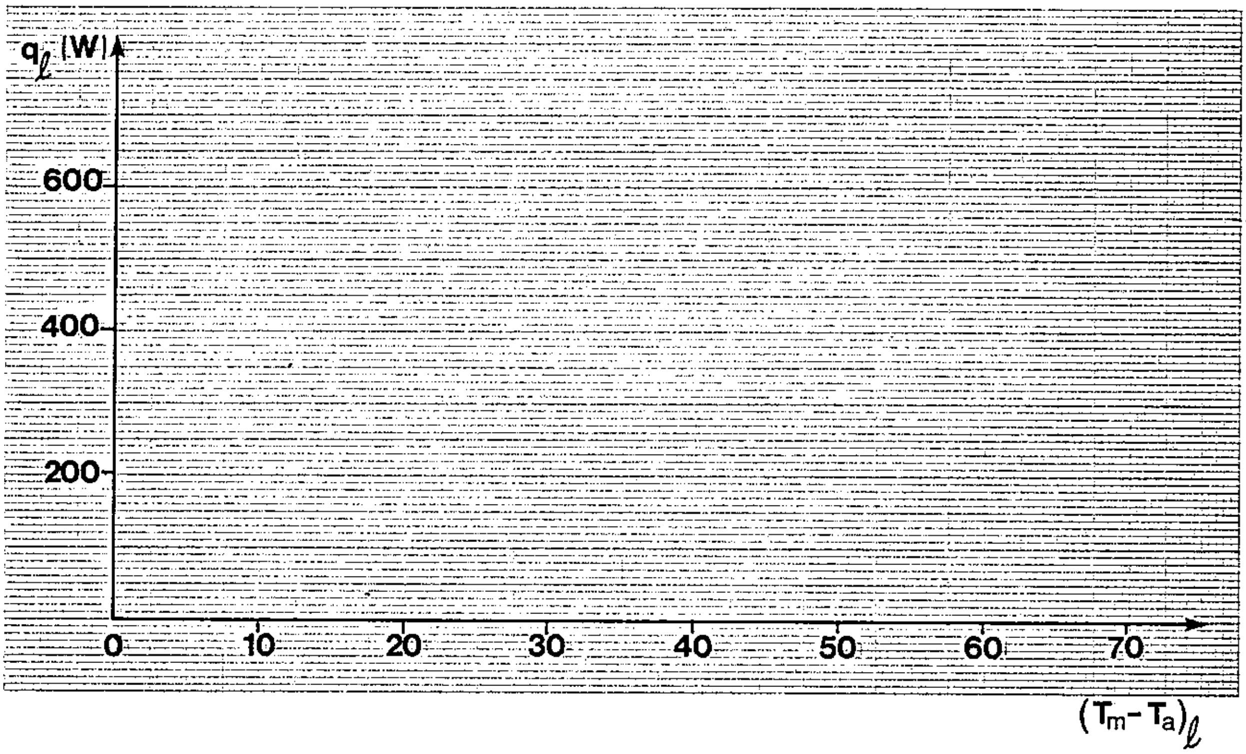
REFERENCE AREA : .... m^2 HEAT CAPACITY : .... KJ/°C

(AZIMUTH refers to collector position)

5. Heat Losses

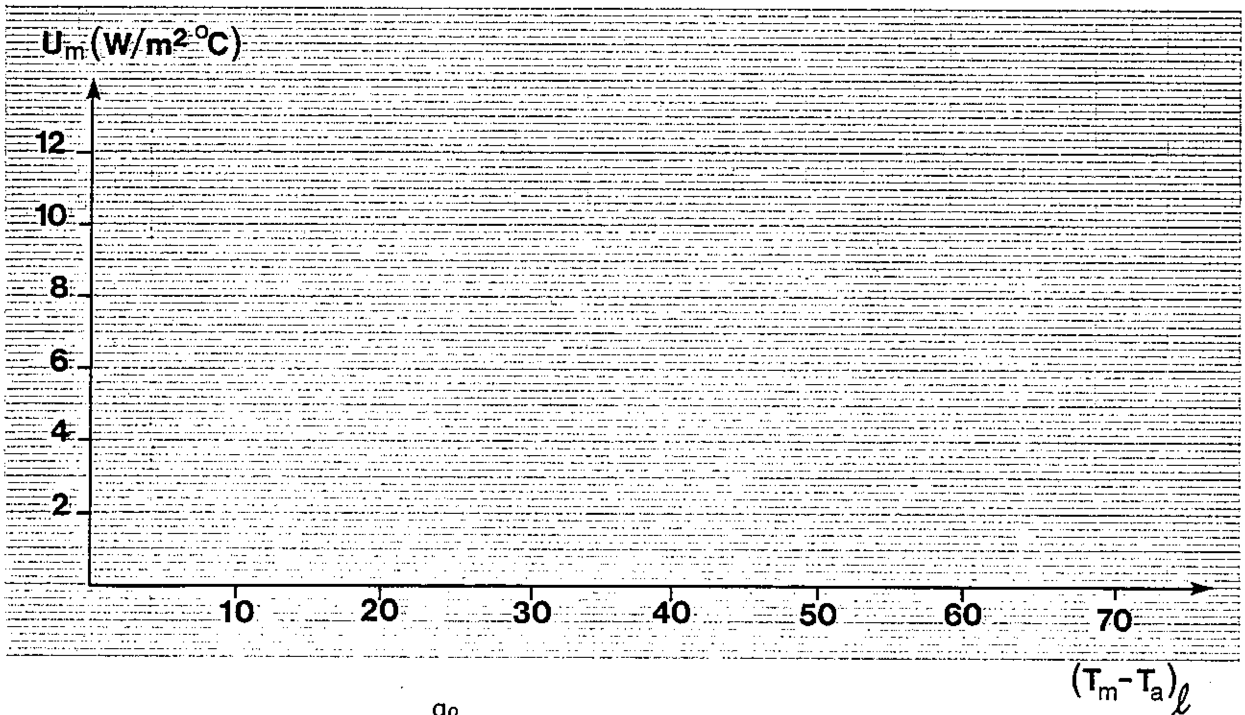
indoor ☐
outdoor ☐

5.1 GLOBAL THERMAL LOSSES



The heat losses q_ℓ are expressed as a function of the temperature difference $(T_m - T_a)_\ell$

5.2 GLOBAL HEAT TRANSFER COEFFICIENT



$$U_m = \frac{q_\ell}{A_a\ (T_m - T_a)_\ell}$$

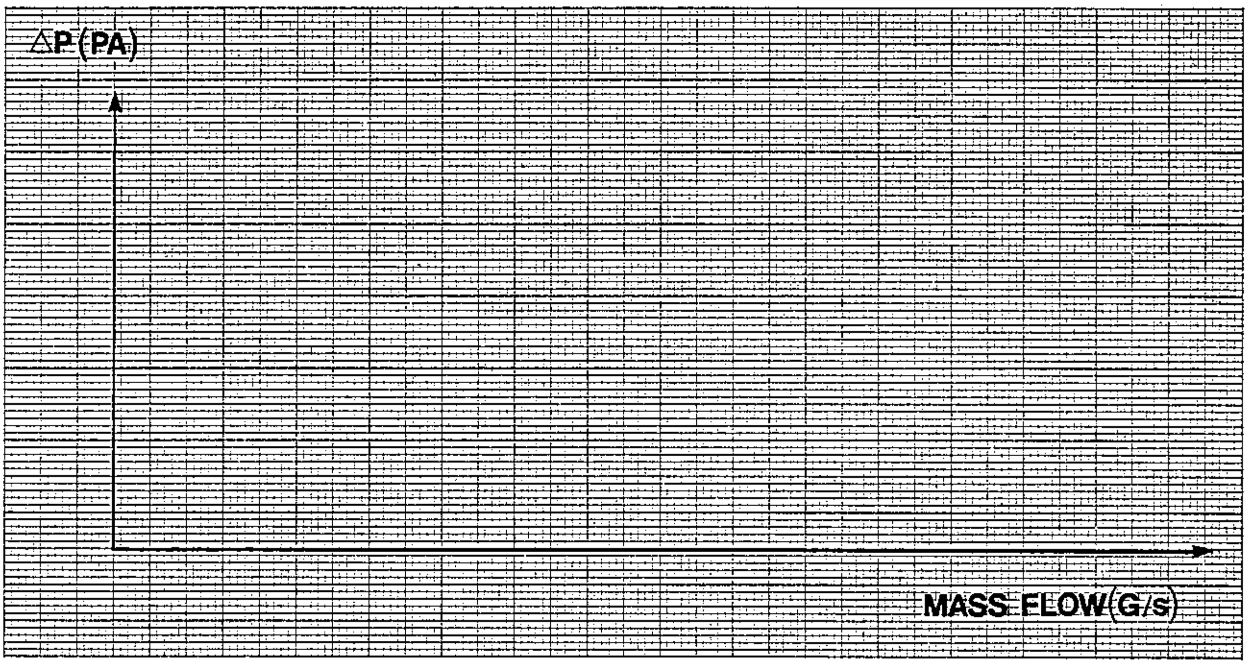
5.3. HEAT LOSSES : EXPERIMENTAL DATA

FLUID .... SLOPE : ....

D	hr	m_f	T_a	T_i	ΔT	T_m	$T_m - T_a$	Q_ℓ	U_m	V	T_{sky}	C_p

REFERENCE AREA : .... m^2 HEAT CAPACITY : .... KJ/°C

6. Pressure Drop



The pressure drop ΔP across the collector is measured with water at ambient temperature

7. Other Methods or Special Remarks

(Give a short description of methods and essential results)

7. Other Methods or Special Remarks *(continued)*

8. Nomenclature

A_g	:	Gross area of collector	(m^2)
A_a	:	Aperture area	(m^2)
A_p	:	Absorber plate area	(m^2)
C_p	:	Specific heat	$(J/g \cdot °C)$
D	:	Date – [day - month - year]	
hr	:	Local time	
I	:	Incident radiation	(W/m^2)
I_d	:	Diffuse incident radiation	(W/m^2)
$\dot{m}_f$	:	Mass flow	(g/s)
q_ℓ	:	Heat losses	(W)
q_u	:	Useful Power	(W)
T_a	:	Ambient temperature	(°C)
T_i	:	Collector inlet temperature	(°C)
T_m	:	Average temperature of fluid in collector	(°C)
T_{SKY}	:	SKY temperature	(°C)
T^*	:	Reduced temperature	dimensionless
ΔT	:	Temperature difference between outlet and inlet	(°C)
U_m	:	Global heat transfer coefficient	$(W/m^2 \cdot °C)$
U_0	:	Normalized coefficient	$U_0 = 10\ W/m^2\ °C$
V	:	Wind velocity	m/s
η_0	:	Efficiency when $T^* = 0$	dimensionless
ΔP	:	Pressure drop	(Pa)

APPENDIX C

Data: IEA-1 Collector

NBS Procedure

COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : NBS/ASHRAE , SITE:AUSTRIA

REFERENCE AREA: 1.789 M**2; FLUID: WATER , SLOPE: 38/47 DEGREE

A

SITE = A   COLLECTOR TYPE IEA I   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 26

ID	NO	DATE	HOUR		ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
	1	77.10.14	13.50	627.0	0.0	35.6	13.40	0.0	5.1	31.8	0.2[illegible]	0.68	1.5	0.0
1	2	77.10.17	14.07	564.0	0.0	31.7	17.20	0.0	4.2	43.1	[illegible].46	0.55	1.5	0.0
1	3	77.10.18	12.03	850.0	0.0	23.3	18.80	0.0	[illegible].3	73.1	0.6[illegible]	0.40	0.5	0.0
1	4	77.10.18	1[illegible].07	753.0	0.0	27.8	19.60	0.0	6.5	61.0	0.55	0.56	1.5	0.0
1	5	77.10.18	14.31	498.0	0.0	29.4	19.30	0.0	3.1	52.0	0.66	0.43	2.0	0.0
1	6	77.10.19	12.57	774.0	0.0	33.3	16.70	0.0	8.0	33.4	0.22	0.80	1.5	0.0
1	7	77.10.19	13.53	627.0	0.0	54.4	17.30	0.0	3.3	35.1	0.28	0.67	1.5	0.0
1	8	77.10.20	13.32	669.0.	0.0	53.3	17.70	0.0	2.5	73.6	0.83	0.46	2.0	0.0
1	9	77.10.21	13.51	537.0	0.0	56.7	18.00	0.0	1.6	57.7	0.74	0.39	2.0	0.0
1	10	77.11.11	13.47	557.0	0.0	20.5	15.60	0.0	7.5	28.7	0.24	0.65	1.0	0.0
1	11	77.11.20	12.12	829.0	0.0	20.8	11.00	0.0	9.3	22.1	0.13	0.54	4.0	0.0
1	12	77.12.19	12.58	738.0	0.0	22.2	2.80	0.0	9.8	21.3	0.25	0.69	1.0	0.0
2	1	78. 6.12	12.52	894.0	0.0	75.8	21.30	0.0	3.6	39.6	0.20	0.63	2.0	0.0
2	2	78. 6.12	13.48	854.0	0.0	77.8	21.40	0.0	3.2	45.9	0.29	0.60	2.0	0.0
2	3	78. 6.12	14.25	591.0	0.0	76.8	22.20	0.0	2.7	42.2	0.33	0.73	2.0	0.0
2	4	78. 6.13	12.44	831.0	0.0	76.2	15.70	0.0	2.5	39.6	0.28	0.46	2.0	0.0
2	5	78. 6.13	13.20	832.0	0.0	76.8	16.60	0.0	2.8	41.7	0.31	0.54	2.0	0.0
2	6	78. 6.13	14.09	861.0	0.0	77.7	17.40	0.0	2.9	42.5	0.29	0.55	2.0	0.0
2	7	78. 6.14	12.09	974.0	0.0	80.1	17.80	0.0	3.7	41.8	0.25	0.62	2.0	0.0
2	8	78. 6.14	12.45	976.0	0.0	80.1	18.90	0.0	3.9	47.8	0.30	0.67	2.0	0.0
2	9	78. 6.19	13.51	875.0	0.0	80.1	19.20	0.0	3.3	49.8	0.35	0.63	2.0	0.0
2	10	78. 6.19	11.15	930.0	0.0	82.0	22.50	0.0	3.2	63.7	0.44	0.60	1.0	0.0
2	11	78. 6.19	12.00	957.0	0.0	83.7	23.60	0.0	3.3	69.6	0.48	0.63	1.0	0.0
2	12	78. 6.19	12.30	974.0	0.0	85.0	23.40	0.0	3.0	73.8	0.51	0.56	1.0	0.0
2	13	78. 6.19	13.14	1032.0	0.0	84.8	23.50	0.0	3.2	76.8	0.52	0.56	1.0	0.0
2	14	78. 6.20	12.44	1010.0	0.0	81.7	19.80	0.0	3.6	63.4	0.43	0.61	2.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

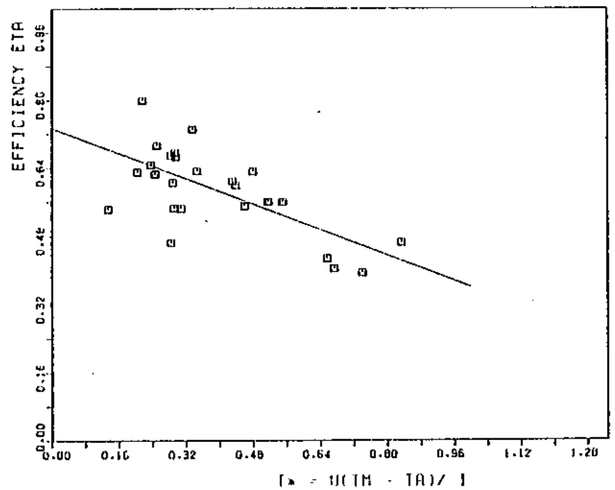
ETA=0.0   0.0 *TSTAR

ETA=0.800   0.367*TSTAR   0.243(TSTAR**2)

LEAST SQUARE FIT

ETA=0.734   -.374*TSTAR

ETA=0.640   0.105*TSTAR   -.509(TSTAR**2)



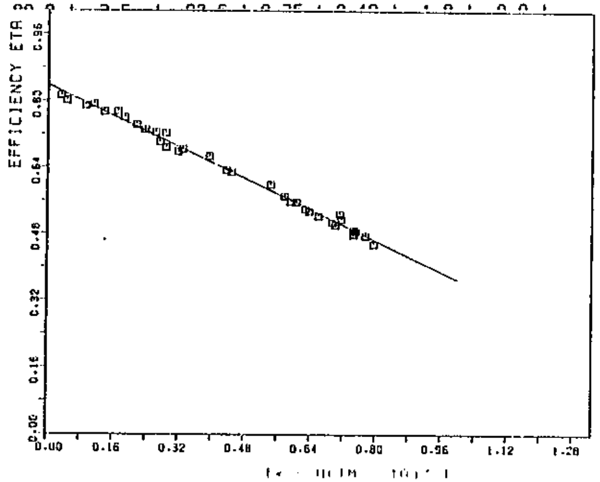
COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : NBS/ASHRAE , SITE:CANADA

REFERENCE AREA: 1.79 M**2, FLUID:H2O/GLYCOL, SLOPE: 40/60 DEGREE

C

SITE = CAN COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1 NUMBER OF DATA POINTS = 34

ID	NO	DATE	HOUR		ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	78. 2.13	12.00	1080.0	0.16	63.6	-8.40	31.6	5.5	34.4	0.39	0.67	2.2	0.0
1	2	78. 2.28	12.00	1098.0	0.15	58.5	-7.00	15.6	7.0	19.1	0.24	0.73	2.7	0.0
1	3	78. 3. 1	12.00	1103.0	0.14	62.7	-6.10	19.7	6.3	22.9	0.26	0.72	1.3	0.0
1	4	78. 3. 4	12.00	1134.0	0.18	64.1	-7.70	21.9	6.0	24.9	0.29	0.69	3.6	0.0
1	5	78. 3. 5	11.45	1097.0	0.22	63.5	-10.40	24.3	5.8	27.2	0.32	0.68	4.0	0.0
1	6	78. 3. 8	12.00	1114.0	0.12	62.8	-4.60	22.7	6.0	25.7	0.27	0.70	2.7	0.0
1	7	78. 3.10	11.18	1039.0	0.16	61.6	3.70	19.9	6.4	23.1	0.19	0.76	1.8	0.0
1	8	78. 3.13	12.00	1058.0	0.16	61.1	5.10	19.8	6.6	23.1	0.17	0.77	1.8	0.0
1	9	78. 3.10	13.09	1002.0	0.17	61.1	8.60	19.2	6.3	22.4	0.14	0.77	1.8	0.0
1	10	78. 3.11	10.49	978.0	0.23	60.0	-0.10	18.1	6.0	21.1	0.22	0.74	1.3	0.0
1	11	78. 3.16	12.00	1085.0	0.13	62.4	-5.20	22.9	6.1	26.0	0.29	0.72	2.2	0.0
1	12	78. 3.17	11.40	1076.0	0.14	63.3	-3.10	71.4	3.9	73.4	0.71	0.53	1.3	0.0
1	13	78. 3.20	10.40	1008.0	0.18	68.1	-6.80	23.4	4.8	25.8	0.33	0.68	2.2	0.0
1	14	78. 3.30	11.25	1086.0	0.14	71.4	2.30	72.0	3.4	73.7	0.66	0.52	3.1	0.0
1	15	78. 3.30	12.00	1103.0	0.13	71.2	3.10	71.7	3.6	73.5	0.64	0.53	3.1	0.0
1	16	78. 3.31	12.00	1081.0	0.15	70.7	5.60	71.9	3.7	73.8	0.63	0.54	3.1	0.0
1	17	78. 4. 2	11.30	1080.0	0.11	71.6	-2.10	43.7	4.4	45.9	0.45	0.63	4.9	0.0
1	18	78. 4. 2	12.00	1092.0	0.11	71.6	-1.40	43.9	4.5	46.2	0.44	0.63	4.9	0.0
2	1	78. 5.27	12.07	899.0	0.18	59.1	31.30	31.2	6.0	34.2	0.03	0.81	1.8	0.0
2	2	78. 5.28	12.00	890.0	0.19	58.2	30.30	31.4	6.0	34.4	0.05	0.80	2.2	0.0
2	3	78. 5.29	11.33	921.0	0.14	56.0	29.60	36.8	6.1	39.9	0.11	0.79	2.2	0.0
2	4	78. 5.30	12.12	869.0	0.26	54.2	31.80	36.8	6.1	39.9	0.09	0.79	1.3	0.0
2	5	78. 6. 3	12.32	986.0	0.18	62.0	17.80	72.9	3.9	74.9	0.58	0.57	2.7	0.0
2	6	78. 6. 4	12.12	1036.0	0.27	61.0	18.40	72.6	4.3	74.8	0.54	0.60	2.2	0.0
2	7	78. 6. 6	11.38	912.0	0.11	60.5	19.30	72.7	3.6	74.5	0.61	0.56	3.1	0.0
2	8	78. 6. 6	12.16	923.0	0.11	60.5	19.80	72.7	3.6	74.5	0.59	0.56	3.1	0.0
2	9	78. 6. 9	11.30	903.0	0.11	57.7	18.80	82.3	3.5	84.1	0.72	0.52	3.1	0.0
2	10	78. 6. 9	12.20	927.0	0.12	57.7	19.90	83.2	3.4	84.9	0.70	0.50	3.1	0.0
2	11	78. 6.10	12.00	928.0	0.0	57.2	14.90	83.4	3.4	84.1	0.75	0.49	2.2	0.0
2	12	78. 6.12	11.28	882.0	0.19	55.9	28.20	87.6	3.3	89.3	0.69	0.51	3.6	0.0
2	13	78. 6.15	12.06	954.0	0.0	55.1	18.30	87.6	3.5	89.4	0.75	0.48	4.0	0.0
2	14	78. 6.16	12.08	931.0	0.10	54.6	22.40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	15	78. 6.16	13.00	885.0	0.09	54.7	23.40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2	16	78. 6.16	13.21	851.0	0.10	54.6	24.20	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]



THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.0 0.0 *TSTAR

ETA=0.831 -.418*TSTAR -.058(TSTAR**2)

LEAST SQUARE FIT

ETA=0.839 -.468*TSTAR

ETA=0.831 -.417*TSTAR -.058(TSTAR**2)

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ; SITE:GERMANY

REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE: 45 DEGREE.JUELICH

D

SITE = D COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1 NUMBER OF DATA POINTS = 16

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELT	TM	T*	ETA	WIND	TSKY
1	1	78. 5.31	9.10	856.0	0.26	36.4	21.40	32.0	7.5	35.7	0.17	0.74	1.2	0.0
1	2	78. 5.31	9.35	836.0	0.25	36.5	22.30	32.0	7.7	35.8	0.16	0.74	1.5	0.0
1	3	78. 5.31	12.35	925.0	0.27	37.7	25.90	51.4	7.1	54.9	0.31	0.68	2.0	0.0
1	4	78. 5.31	13.10	942.0	0.26	37.6	26.50	51.4	7.5	55.1	0.30	0.70	2.1	0.0
1	5	78. 6. 1	9.25	868.0	0.25	38.1	23.50	70.0	5.4	72.7	0.57	0.55	1.0	0.0
1	6	78. 6. 1	10.15	904.0	0.23	38.1	25.50	70.0	6.0	73.0	0.52	0.59	1.2	0.0
1	7	78. 6. 1	14.35	957.0	0.34	43.6	29.40	80.9	5.1	83.4	0.56	0.55	1.0	0.0
1	8	78. 6. 2	9.00	752.0	0.37	43.4	23.20	94.8	2.6	96.0	0.97	0.35	1.0	0.0
1	9	78. 6. 2	9.30	777.0	0.36	43.4	23.40	94.8	2.7	96.2	0.94	0.35	2.0	0.0
1	10	78. 6.16	13.20	887.0	0.39	37.8	27.80	59.5	2.9	62.1	0.45	0.61	1.0	0.0
1	11	78. 6.19	9.40	894.0	0.32	39.2	20.00	26.5	7.5	30.2	0.11	0.77	0.8	0.0
1	12	78. 6.19	10.15	918.0	0.31	39.6	21.10	26.5	7.6	30.3	0.10	0.77	0.8	0.0
1	13	78. 6.19	10.50	975.0	0.29	38.1	21.60	26.4	8.4	30.6	0.09	0.77	1.0	0.0
1	14	78. 6.19	13.30	988.0	0.32	39.5	24.20	25.0	8.3	29.2	0.05	0.78	1.0	0.0
1	15	78. 6.19	14.00	985.0	0.28	39.6	24.20	25.3	8.3	29.4	0.05	0.78	0.8	0.0
1	16	78. 6.19	16.20	809.0	0.29	41.0	23.50	59.5	5.2	62.1	0.48	0.62	0.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.0 0.0 *TSTAR

ETA=0.800 -.360*TSTAR -.130(TSTAR**2)

LEAST SQUARE FIT

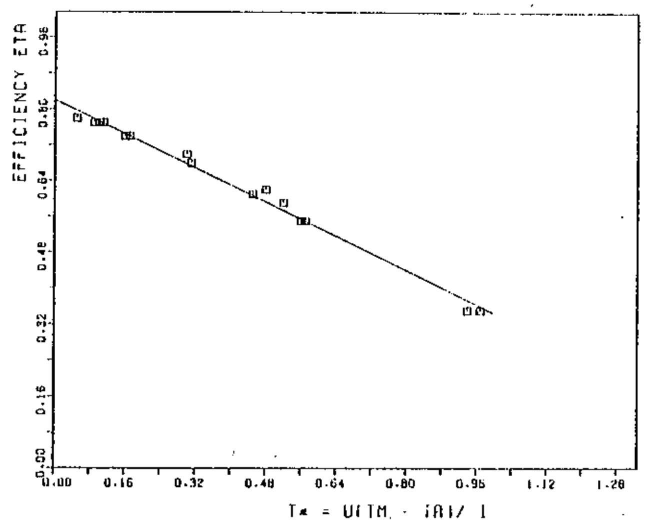
ETA=0.821 -.477*TSTAR

ETA=0.804 -.356*TSTAR -.126(TSTAR**2)

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ; SITE:GERMANY

REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE: 45 DEGREE.JUELICH

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : NBS/ASHRAE , SITE:GERMANY

REFERENCE AREA: 1.79 M**2, FLUID: WATER , SLOPE: ? DEGREE, HEIDELBERG

D

SITE = D COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRA /BSE = 1/2) = 1 NUMBER OF DATA POINTS : 29

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	0. 0. 0	0.0	896.0	0.0	31.3	15.30	0.0	9.2	27.3	0.13	0.75	0.8	0.0
1	2	0. 0. 0	0.0	951.0	0.0	31.6	15.40	0.0	9.0	36.5	0.21	0.70	0.8	0.0
1	3	0. 0. 0	0.0	956.0	0.0	31.3	17.70	0.0	8.8	46.6	0.31	0.67	0.8	0.0
1	4	0. 0. 0	0.0	916.0	0.0	31.3	16.80	0.0	7.5	55.2	0.42	0.60	0.8	0.0
1	5	0. 0. 0	0.0	920.0	0.0	31.3	17.90	0.0	7.6	65.4	0.52	0.60	1.3	0.0
1	6	0. 0. 0	0.0	836.0	0.0	31.7	18.30	0.0	6.1	74.8	0.68	0.52	1.3	0.0
1	7	0. 0. 0	0.0	738.0	0.0	31.2	17.60	0.0	4.6	83.3	0.89	0.46	1.0	0.0
1	8	0. 0. 0	0.0	907.0	0.0	31.9	16.90	0.0	7.0	94.3	0.85	0.56	0.0	0.0
1	9	0. 0. 0	0.0	936.0	0.0	32.2	18.20	0.0	6.8	85.6	0.72	0.53	0.0	0.0
1	10	0. 0. 0	0.0	943.0	0.0	32.1	20.70	0.0	8.0	85.4	0.58	0.62	0.0	0.0
1	11	0. 0. 0	0.0	993.0	0.0	32.2	20.00	0.0	8.1	65.6	0.46	0.61	0.0	0.0
1	12	0. 0. 0	0.0	980.0	0.0	32.3	22.10	0.0	7.2	58.5	0.37	0.57	0.0	0.0
1	13	0. 0. 0	0.0	901.0	0.0	35.8	11.20	0.0	6.2	73.9	0.70	0.57	0.3	0.0
1	14	0. 0. 0	0.0	968.0	0.0	35.6	12.20	0.0	6.7	74.1	0.64	0.56	0.3	0.0
1	15	0. 0. 0	0.0	1044.0	0.0	35.6	13.20	0.0	7.4	74.6	0.59	0.58	0.3	0.0
1	16	0. 0. 0	0.0	1047.0	0.0	36.9	17.90	0.0	9.0	46.4	0.27	0.73	0.0	0.0
1	17	0. 0. 0	0.0	862.0	0.0	43.8	29.40	0.0	7.4	36.3	0.08	0.87	5.0	0.0
1	18	0. 0. 0	0.0	717.0	0.0	38.9	28.80	0.0	6.3	35.6	0.09	0.79	5.0	0.0
1	19	0. 0. 0	0.0	903.0	0.0	36.4	25.50	0.0	8.5	36.7	0.12	0.80	5.0	0.0
1	20	0. 0. 0	0.0	910.0	0.0	32.0	23.30	0.0	9.5	37.3	0.15	0.78	5.0	0.0
1	21	0. 0. 0	0.0	917.0	0.0	32.3	23.50	0.0	9.8	38.6	0.16	0.80	5.0	0.0
1	22	0. 0. 0	0.0	923.0	0.0	31.1	23.10	0.0	9.9	38.4	0.17	0.80	5.0	0.0
1	23	0. 0. 0	0.0	904.0	0.0	30.8	24.00	0.0	9.9	38.5	0.16	0.79	5.0	0.0
1	24	0. 0. 0	0.0	894.0	0.0	31.0	23.80	0.0	10.0	38.5	0.16	0.80	5.0	0.0
1	25	0. 0. 0	0.0	889.0	0.0	31.1	24.80	0.0	10.0	38.4	0.15	0.81	5.0	0.0
1	26	0. 0. 0	0.0	864.0	0.0	43.8	25.30	0.0	7.4	32.2	0.08	0.87	5.0	0.0
1	27	0. 0. 0	0.0	717.0	0.0	38.9	25.10	0.0	6.3	31.9	0.09	0.79	5.0	0.0
1	28	0. 0. 0	0.0	903.0	0.0	36.4	26.00	0.0	8.5	37.2	0.12	0.80	5.0	0.0
1	29	0. 0. 0	0.0	910.0	0.0	32.0	25 [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

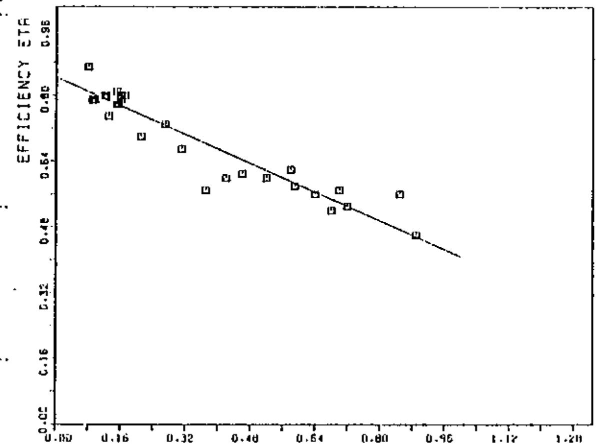
ETA=0.836 -.422*TSTAR

ETA=0.0 0.0 *TSTAR 0.0 (TSTAR**2)

LEAST SQUARE FIT

ETA=0.844 -.436*TSTAR

ETA=0.898 -.836*TSTAR 0.460(TSTAR**2)



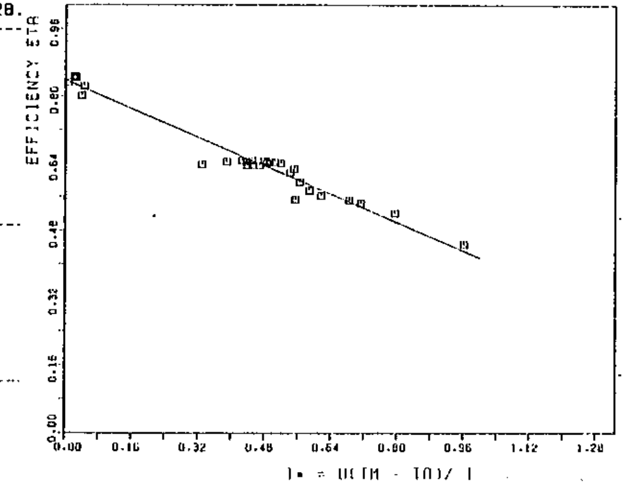
COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : NBS/ASHRAE , SITE:GERMANY

REFERENCE AREA: 1.789 M**2, FLUID: WATER , SLOPE: 40.5 DEGREE.STUTT.

D

SITE = D COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHR.?/BSE = 1/2) = 1 NUMBER OF DATA POINTS = 30

ID	NO	DATE	HOUR		IO/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
	1	78. 5.27	10.33	788.5	0.27	34.4	19.81	0.0	6.2	54.4	0.44	0.64	0.0	0.0
	2	78. 5.27	10.58	857.6	0.26	35.5	19.64	0.0	6.9	56.2	0.43	0.65	0.0	0.0
	3	78. 5.28	10.19	747.3	0.26	35.9	20.94	0.0	5.6	55.9	0.47	0.64	0.0	0.0
	4	78. 5.28	10.54	820.4	0.29	36.6	21.16	0.0	6.1	58.3	0.45	0.64	0.0	0.0
	5	78. 5.29	9.47	652.0	0.31	42.0	22.00	0.0	3.7	62.2	0.62	0.56	0.0	0.0
	6	78. 5.29	10.59	810.5	0.30	42.3	22.78	0.0	5.3	63.7	0.50	0.64	0.0	0.0
	7	78. 5.30	9.42	648.8	0.24	36.4	24.26	0.0	4.4	62.3	0.59	0.58	0.0	0.0
	8	78. 5.30	10.10	718.7	0.29	36.9	23.61	0.0	5.1	62.5	0.54	0.62	0.0	0.0
	9	78. 5.30	11.57	913.9	0.20	37.7	24.28	0.0	6.7	64.3	0.44	0.64	0.0	0.0
	10	78. 5.30	13.10	895.0	0.21	37.7	24.51	0.0	6.6	68.5	0.49	0.65	0.0	0.0
	11	78. 5.31	10.13	733.7	0.28	38.3	21.45	0.0	4.5	62.1	0.55	0.55	0.0	0.0
	12	78. 5.31	12.14	889.2	0.21	37.8	23.33	0.0	6.5	65.9	0.48	0.65	0.0	0.0
	13	78. 5.31	13.44	819.9	0.23	37.8	24.11	0.0	5.9	66.6	0.52	0.64	0.0	0.0
	14	78. 5.31	14.52	681.1	0.25	38.0	26.77	0.0	4.6	65.2	0.56	0.60	0.0	0.0
	15	78. 6. 1	10.34	714.6	0.30	38.8	23.48	0.0	3.5	92.2	0.96	0.45	0.0	0.0
	16	78. 6. 1	11.21	752.5	0.33	37.8	24.84	0.0	4.4	84.6	0.79	0.52	0.0	0.0
	17	78. 6. 1	12.00	866.2	0.24	37.2	25.70	0.0	5.5	84.9	0.68	0.55	0.0	0.0
	18	78. 6. 1	13.01	811.2	0.25	36.3	26.51	0.0	5.2	84.3	0.71	0.55	0.0	0.0
	19	78. 6. 2	10.03	668.4	0.31	36.6	26.42	0.0	5.0	48.4	0.33	0.64	0.0	0.0
	20	78. 6. 2	11.09	794.4	0.28	30.6	27.67	0.0	7.1	58.5	0.39	0.64	0.0	0.0
	21	78. 6. 2	12.05	865.2	0.27	31.1	27.09	0.0	7.7	65.9	0.45	0.65	0.0	0.0
	22	78. 6. 2	12.51	842.4	0.28	31.3	28.74	0.0	7.4	69.6	0.49	0.64	0.0	0.0
	23	78. 6. 2	14.02	800.1	0.31	32.3	28.38	0.0	6.6	72.5	0.55	0.63	0.0	0.0
	24	78. 6. 3	10.20	738.5	0.23	36.3	28.48	0.0	7.3	29.0	0.01	0.83	0.0	0.0
	25	78. 6. 3	11.30	856.1	0.20	36.3	27.96	0.0	8.6	29.6	0.02	0.85	0.0	0.0
	26	78. 6. 4	10.05	693.2	0.27	36.7	26.73	0.0	6.5	29.4	0.04	0.80	0.0	0.0
	27	78. 6. 4	10.52	758.3	0.26	36.6	26.74	0.0	7.6	30.3	0.05	0.82	0.0	0.0
	28	78. 6. 4	11.41	833.9	0.26	36.9	28.35	0.0	8.2	30.5	0.02	0.85	0.0	0.0
	29	78. 6. 4	12.03	840.2	0.26	36.9	28.39	0.0	8.2	30.6	0.03	0.84	0.0	0.0
	30	78. 6. 4	12.58	861.5	0.26	36.7	28.							



THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.838 -.424*TSTAR

ETA=0.0 0.0 *TSTAR 0.0 (TSTAR**2)

LEAST SQUARE FIT

ETA=0.838 -.423*TSTAR

ETA-0.846 -.501*TSTAR 0.102(TSTAR**2)

COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : NBS/ASHRAE ,SITE:DENMARK
REFERENCE AREA: 1.78 M**2, FLUID: WATER , SLOPE:45 DEGREE,COPENHAGEN

DK

SITE = DK COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1 NUMBER OF DATA POINTS = 40

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	77. 8. 2	11.15	961.0	0.22	33.7	21.40	0.0	10.4	19.8	0.04	0.85	6.0	0.0
1	2	77. 8. 2	11.30	951.0	0.23	33.3	21.70	0.0	10.3	19.9	0.04	0.84	6.0	0.0
1	3	77. 8. 2	11.45	944.0	0.23	33.0	21.60	0.0	10.3	19.8	0.04	0.84	6.0	0.0
1	4	77. 8. 2	12.00	976.0	0.22	32.7	22.00	0.0	10.6	19.9	0.03	0.83	6.0	0.0
1	5	77. 8. 2	12.15	984.0	0.23	32.7	22.30	0.0	10.9	19.9	0.03	0.84	6.0	0.0
1	6	77. 8. 2	12.30	980.0	0.24	32.3	22.20	0.0	10.8	19.9	0.03	0.83	6.0	0.0
1	7	77. 8. 5	11.15	898.0	0.33	35.2	21.30	0.0	9.2	22.9	0.07	0.84	6.0	0.0
1	8	77. 8. 5	11.30	907.0	0.33	35.2	21.60	0.0	9.3	22.9	0.07	0.84	6.0	0.0
1	9	77. 8. 5	11.45	898.0	0.35	35.2	21.50	0.0	9.2	22.9	0.07	0.84	6.0	0.0
1	10	77. 8. 5	12.00	916.0	0.36	35.2	21.50	0.0	9.2	22.9	0.07	0.82	6.0	0.0
1	11	77. 8. 5	12.15	918.0	0.37	35.2	21.60	0.0	9.4	22.9	0.06	0.84	6.0	0.0
1	12	77. 8. 5	12.30	886.0	0.40	35.7	21.70	0.0	9.1	22.9	0.06	0.85	6.0	0.0
2	1	77. 8.24	11.00	930.0	0.26	37.7	17.30	0.0	7.4	43.0	0.32	0.70	2.0	0.0
2	2	77. 8.24	11.15	913.0	0.29	37.7	17.40	0.0	7.2	42.9	0.32	0.69	2.0	0.0
2	3	77. 8.24	11.30	830.0	0.28	37.7	17.50	0.0	6.4	42.9	0.34	0.67	2.0	****
2	4	77. 8.24	11.45	998.0	0.27	37.7	17.70	0.0	8.0	43.0	0.29	0.71	2.0	****
2	5	77. 8.24	12.00	967.0	0.24	37.7	17.80	0.0	7.7	42.9	0.30	0.70	2.0	****
2	6	77. 8.24	12.15	908.0	0.22	37.7	18.50	0.0	7.9	43.0	0.29	0.71	2.0	****
2	7	77. 8.24	12.30	983.0	0.21	37.7	18.50	0.0	7.9	43.0	0.29	0.71	2.0	0.0
2	8	77. 8.24	12.45	982.0	0.22	37.7	18.00	0.0	7.9	43.1	0.29	0.71	2.0	0.0
2	9	77. 8.16	11.15	957.0	0.0	37.6	17.70	0.0	7.2	47.7	0.35	0.66	6.0	****
2	10	77. 8.16	11.30	964.0	0.0	37.6	17.70	0.0	7.3	47.9	0.35	0.66	6.0	****
2	11	77. 8.16	11.45	973.0	0.0	37.6	18.00	0.0	7.4	47.9	0.35	0.66	6.0	****
2	12	77. 8.16	12.00	973.0	0.0	37.6	18.30	0.0	7.4	47.9	0.34	0.67	6.0	****
2	13	77. 8.15	12.15	965.0	0.0	37.6	18.60	0.0	7.4	47.9	0.34	0.67	6.0	****
2	14	77. 8.16	12.30	959.0	0.0	37.6	18.60	0.0	7.3	47.9	0.34	0.67	6.0	****
2	15	77. 8.17	11.30	851.0	0.37	32.3	21.30	0.0	5.8	69.2	0.60	0.52	1.0	****
2	16	77. 8.17	11.45	944.0	0.25	32.3	21.60	0.0	7.3	69.3	0.54	0.59	1.0	****
2	17	77. 8.17	12.00	982.0	0.23	32.3	21.90	0.0	7.2	69.3	0.52	0.56	1.0	****
2	18	77. 8.17	12.15	937.0	0.24	32.3	22.10	0.0	7.1	69.3	0.54	0.58	1.0	****
2	19	77. 8.32	11.15	974.0	0.18	35.5	17.40	0.0	5.4	77.6	0.66	0.46	2.0	****
2	20	77. 8.22	11.30	990.0	0.19	35.3	17.60	0.0	5.8	78.8	0.65	0.49	2.0	****
2	21	77. 8.22	11.45	985.0	0.21	35.3	17.80	0.0	6.0	78.5	0.65	0.50	2.0	****
2	22	77. 8.22	12.00	981.0	0.19	35.2	17.90	0.0	5.9	78.7	0.65	0.50	2.0	****
2	23	77. 8.22	12.15	978.0	0.20	35.0	18.00	0.0	6.1	78.8	0.65	0.51	2.0	****
2	24	77. 8.22	12.30	962.0	0.20	34.9	17.90	0.0	5.9	78.7	0.66	0.50	2.0	****
2	25	77. 8.30	11.30	894.0	0.28	32.2	20.80	0.0	4.6	87.4	0.77	0.39	6.0	-5.0
2	26	77. 8.30	11.45	901.0	0.28	32.2	20.90	0.0	4.8	87.6	0.77	0.40	6.0	-5.0
2	27	77. 8.30	12.00	882.0	0.31	32.6	20.40	0.0	4.6	87.7	0.79	0.40	6.0	-5.0
2	28	77. 8.30	12.15	880.0	0.31	32.6	21.10	0.0	4.4	87.6	0.78	0.39	6.0	-5.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

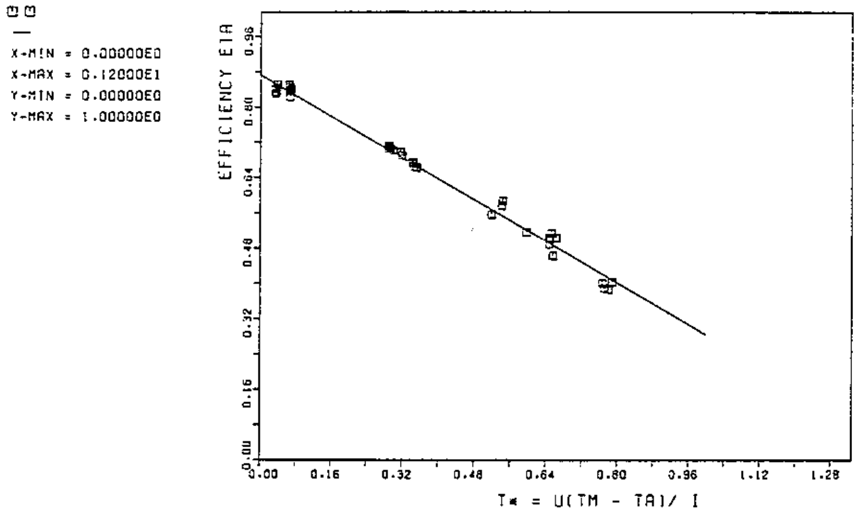
ETA=0.0 0.0 *TSTAR

ETA=0.0 0.0 *TSTAR 0.0 (TSTAR**2)

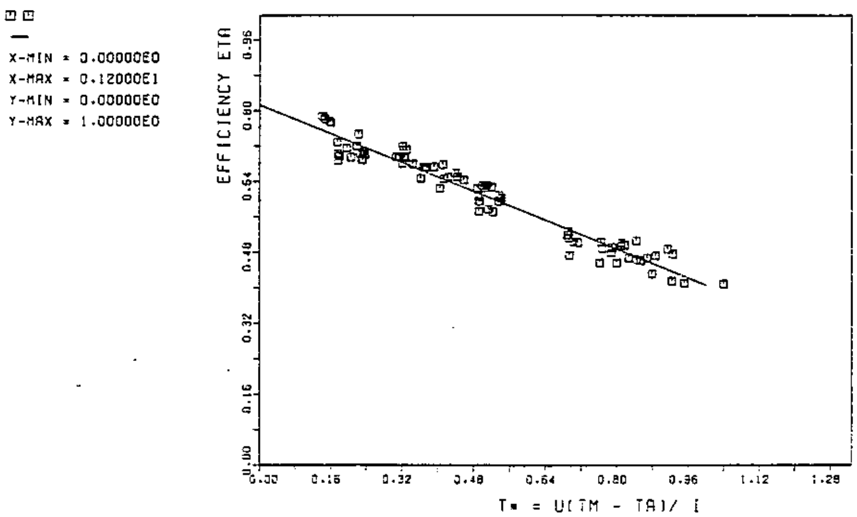
LEAST SQUARE FIT

ETA=0.873 -.589*TSTAR

COLLECTOR TYPE: IEA-1 : TESTING PROCEDURE : NBS/ASHRAE :SITE:DENMARK
REFERENCE AREA: 1.78 M**2: FLUID: WATER : SLOPE:45 DEGREE.COPENHAGEN



COLLECTOR TYPE: IEA-1 : TESTING PROCEDURE : NBS/ASHRAE :SITE:G.BRITAIN
REFERENCE AREA: 1.785 M**2: FLUID: WATER : SLOPE:45 DEGREE. CARDIFF



COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : NBS/ASHRAE (SITE:G.BRITAIN

REFERENCE AREA: 1.785 M**2, FLUID: WATER , SLOPE:45 DEGREE, CARDIFF

GB

SITE = GB COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1 NUMBER OF DATA POINTS = 82

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	77. 8.23	11.45	894.0	0.20	25.5	20.00	0.0	10.6	35.6	0.18	0.73	0.5	0.0
1	2	77. 8.23	11.50	902.0	0.19	25.5	20.10	0.0	10.6	36.0	0.18	0.70	0.5	0.0
1	3	77. 8.23	11.55	902.0	0.19	25.5	20.60	0.0	10.4	36.5	0.18	0.69	0.5	0.0
1	4	77. 8.23	12.00	894.0	0.19	25.5	21.10	0.0	10.5	37.2	0.18	0.70	0.5	0.0
1	5	77. 8.23	12.05	886.0	0.19	25.5	20.50	0.0	10.6	38.0	0.20	0.72	1.0	0.0
1	6	77. 8.23	12.15	919.0	0.19	25.5	20.00	0.0	10.7	38.9	0.21	0.70	1.5	0.0
1	7	77. 8.23	12.20	862.0	0.20	25.5	20.30	0.0	10.8	39.5	0.22	0.75	0.5	0.0
1	8	77. 8.23	12.25	894.0	0.20	25.5	20.50	0.0	10.8	40.0	0.22	0.72	0.5	0.0
1	9	77. 8.23	12.30	902.0	0.20	25.5	20.00	0.0	10.6	40.5	0.23	0.70	0.5	0.0
1	10	77. 8.23	12.35	910.0	0.20	25.5	20.00	0.0	10.8	41.1	0.23	0.71	0.5	0.0
1	11	77. 8.23	12.40	927.0	0.18	25.5	20.10	0.0	10.7	41.5	0.23	0.69	1.0	0.0
1	12	77. 8.23	12.45	927.0	0.18	25.5	20.50	0.0	10.7	42.0	0.23	0.69	1.0	0.0
1	13	77. 8.23	12.50	919.0	0.18	25.5	20.90	0.0	10.8	42.6	0.24	0.70	1.0	0.0
1	14	77. 9. 9	9.50	691.0	0.09	25.5	16.00	0.0	9.1	20.1	0.15	0.78	0.5	0.0
1	15	77. 9. 9	9.55	699.0	0.09	25.5	16.00	0.0	9.2	26.3	0.15	0.78	0.5	0.0
1	16	77. 9. 9	10.05	724.0	0.12	25.5	17.00	0.0	9.6	27.2	0.14	0.79	1.5	0.0
1	17	77. 9. 9	10.10	748.0	0.12	25.5	16.00	0.0	9.8	27.8	0.16	0.78	1.0	0.0
1	18	77. 9. 9	10.15	764.0	0.12	25.5	16.00	0.0	9.9	28.3	0.16	0.77	1.5	0.0
1	19	77. 9. 9	11.15	862.0	0.10	25.5	18.00	0.0	10.4	45.7	0.32	0.72	1.0	0.0
1	20	77. 9. 9	11.20	911.0	0.10	25.5	18.00	0.0	10.6	46.6	0.31	0.70	1.5	0.0
1	21	77. 9. 9	11.30	886.0	0.10	25.5	18.00	0.0	10.6	46.7	0.32	0.71	1.5	0.0
1	22	77. 9. 9	11.45	911.0	0.10	25.5	18.50	0.0	10.4	47.8	0.32	0.68	1.5	0.0
1	23	77. 9. 9	11.50	919.0	0.13	25.5	18.20	0.0	10.7	48.1	0.32	0.70	1.5	0.0
1	24	77. 9. 9	11.55	935.0	0.12	25.5	18.10	0.0	10.9	48.7	0.33	0.69	1.5	0.0
1	25	77. 9. 9	14.32	740.0	0.16	25.5	18.00	0.0	5.4	83.0	0.88	0.43	1.5	0.0
1	26	77. 9. 9	14.50	699.0	0.19	25.5	18.00	0.0	4.9	82.5	0.92	0.42	1.5	0.0
1	27	77. 9. 9	14.55	683.0	0.20	25.5	17.50	0.0	4.7	82.4	0.95	0.41	1.5	0.0
1	28	77. 9. 9	15.32	569.0	0.28	25.5	17.50	0.0	3.9	76.5	1.04	0.41	1.5	0.0
1	29	77. 9.13	14.15	841.0	0.14	25.5	18.30	0.0	9.8	44.2	0.31	0.70	1.5	0.0
1	30	77. 9.13	14.20	837.0	0.14	25.5	18.30	0.0	9.8	44.7	0.31	0.69	1.5	0.0
1	31	77. 9.13	14.25	789.0	0.15	25.5	18.50	0.0	9.4	44.6	0.33	0.71	1.5	0.0
1	32	77. 9.13	14.40	748.0	0.18	25.5	19.00	0.0	8.5	44.8	0.35	0.68	1.5	0.0
1	33	77. 9.13	14.50	740.0	0.19	25.5	17.80	0.0	8.1	44.6	0.36	0.65	1.5	0.0
1	34	77. 9.13	14.55	720.0	0.17	25.5	18.80	0.0	8.1	45.3	0.37	0.67	1.5	0.0
1	35	77. 9.13	15.00	720.0	0.17	25.5	18.50	0.0	8.1	45.6	0.38	0.67	1.5	0.0
1	36	77. 9.13	15.10	703.0	0.17	25.5	19.50	0.0	7.9	45.7	0.37	0.67	1.5	0.0
1	37	77. 9.13	15.15	683.0	0.17	25.5	19.00	0.0	7.7	45.8	0.39	0.67	1.5	0.0
1	38	77. 9.13	15.20	675.0	0.18	25.5	18.00	0.0	7.7	45.8	0.41	0.68	1.5	0.0
1	39	77. 9.13	15.30	663.0	0.17	25.5	18.30	0.0	7.2	46.3	0.42	0.65	1.5	0.0
1	40	77. 9.13	15.35	646.0	0.18	25.5	18.10	0.0	7.1	46.5	0.44	0.66	1.5	0.0
1	41	77. 9.13	15.40	618.0	0.18	25.5	19.00	0.0	6.8	46.5	0.44	0.65	1.5	0.0
1	42	77. 9.13	15.45	602.0	0.18	25.5	18.90	0.0	6.5	46.4	0.46	0.64	1.5	0.0
1	43	77. 9.14	10.30	667.0	0.17	25.5	17.90	0.0	7.0	44.9	0.40	0.62	0.5	0.0
1	44	77. 9.14	10.35	659.0	0.17	25.5	18.20	0.0	7.1	45.4	0.41	0.65	1.0	0.0
1	45	77. 9.14	11.50	764.0	0.15	25.5	19.20	0.0	7.6	60.0	0.53	0.60	0.5	0.0
1	46	77. 9.14	11.55	780.0	0.15	25.5	19.00	0.0	7.5	59.8	0.52	0.57	1.5	0.0
1	47	77. 9.14	12.00	821.0	0.21	25.5	20.00	0.0	7.9	60.4	0.49	0.57	1.0	0.0
1	48	77. 9.14	12.05	829.0	0.21	25.5	20.10	0.0	8.3	60.9	0.49	0.60	1.0	0.0
1	49	77. 9.14	12.10	821.0	0.21	25.5	20.40	0.0	8.4	60.7	0.49	0.61	1.0	0.0
1	50	77. 9.14	12.15	829.0	0.21	25.5	20.50	0.0	8.7	61.0	0.49	0.63	1.0	0.0
1	51	77. 9.14	12.25	748.0	0.22	25.5	20.20	0.0	7.5	60.3	0.54	0.60	0.5	0.0
1	52	77. 9.14	12.30	756.0	0.22	25.5	20.20	0.0	7.7	60.8	0.54	0.61	1.5	0.0
1	53	77. 9.14	12.35	756.0	0.22	25.5	20.00	0.0	7.6	60.9	0.54	0.60	1.0	0.0
1	54	77. 9.14	12.40	780.0	0.21	25.5	19.80	0.0	8.2	60.4	0.52	0.63	1.0	0.0
1	55	77. 9.14	12.45	796.0	0.20	25.5	20.20	0.0	7.7	61.0	0.51	0.58	1.0	0.0
1	56	77. 9.14	12.50	829.0	0.19	25.5	20.20	0.0	8.8	61.6	0.50	0.63	1.0	0.0

GB

1	57	177.	9.14	12.55	813.0	0.19	25.5	20.10	0.0	8.6	61.4	0.51	0.63	1.0	0.0
1	58	177.	9.14	13.00	821.0	0.19	25.5	20.10	0.0	8.6	61.5	0.50	0.63	1.0	0.0
1	59	177.	9.14	13.05	829.0	0.19	25.5	20.50	0.0	8.3	61.5	0.49	0.60	1.0	0.0
1	60	177.	9.14	14.10	772.0	0.20	25.5	20.20	0.0	6.8	73.6	0.69	0.53	3.0	0.0
1	61	177.	9.14	14.15	756.0	0.24	25.5	20.80	0.0	6.0	73.2	0.69	0.47	2.5	0.0
1	62	177.	9.14	14.20	748.0	0.24	25.5	20.70	0.0	6.3	73.1	0.70	0.50	2.0	0.0
1	63	177.	9.14	14.25	764.0	0.24	25.5	20.60	0.0	6.7	73.2	0.69	0.52	3.5	0.0
1	64	177.	9.14	14.30	756.0	0.24	25.5	20.40	0.0	6.5	72.6	0.69	0.51	2.0	0.0
1	65	177.	9.14	14.35	732.0	0.25	25.5	20.50	0.0	6.2	72.6	0.71	0.50	2.5	0.0
1	66	177.	9.14	14.55	602.0	0.31	25.5	20 60	0.0	5.1	71.3	0.84	0.51	2.0	0.0
1	67	177.	9.14	15.00	626.0	0.30	25.5	20.50	0.0	5.2	71.2	0.81	0.49	2.5	0.0
1	68	177.	9.14	15.05	618.0	0.26	25.5	20.70	0.0	5.2	70.7	0.81	0.50	1.5	0.0
1	69	177.	9.14	15.10	626.0	0.26	25.5	20.50	0.0	5.0	69.8	0.79	0.48	1.0	0.0
1	70	177.	9.14	15.15	634.0	0.23	25.5	20.50	0.0	5.2	69.2	0.77	0.49	2.0	0.0
1	71	177.	9.14	15.20	634.0	0.23	25.5	20.20	0.0	5.4	68 7	0.76	0.50	2.5	0.0
1	72	177.	9.14	15.25	626.0	0.22	25.5	20.80	0.0	4.8	68.5	0.76	0.46	2.5	0.0
1	73	177.	9.14	15.30	610.0	0.23	25.5	20.10	0.0	5.0	68.2	0.79	0.49	2.0	0.0
1	74	177.	9.14	15.35	593.0	0.22	25.5	20.20	0.0	4.6	67.6	0.80	0.46	2.0	0.0
1	75	177.	9.14	15.40	585.0	0.22	25.5	20.10	0.0	4.9	67.9	0.82	0.50	3.0	0.0
1	76	177.	9.14	15.45	569.0	0.23	25.5	20.00	0.0	4.5	67.0	0.83	0.47	2.5	0.0
1	77	177.	9.14	15.50	553.0	0.22	25.5	20.00	0.0	4.3	66.6	0.84	0.46	2.0	0.0
1	78	177.	9.14	15.55	545.0	0.22	25.5	19.80	0.0	4.2	66.3	0.85	0.46	2.0	0.0
1	79	177.	9.14	16.00	528.0	0.0	25.5	20.00	0.0	4.1	65.8	0.87	0.47	2.0	0.0
1	80	177.	9.14	16.05	512.0	0.0	25.5	20.10	0.0	4.1	65.5	0.89	0.47	0.0	0.0
1	81	177.	9.14	16.10	496.0	0.0	25.5	20.00	0.0	4.1	65.3	0.91	0.49	0.0	0.0
1	82	177.	9.14	16.15	488.0	0.0	25.5	20.00	0.0	3.9	65.1	0.93	0.48	0.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.840 -.450*TSTAR

ETA=0.0 0.0 *TSTAR 0.0 (TSTAR**2)

LEAST SQUARE FIT

ETA=0.813 -.408*TSTAR

ETA=0.818 -.427*TSTAR 0.018(TSTAR**2)

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ;SITE:JAPAN

REFERENCE AREA: 1.785 M**2; FLUID: WATER;SLOPE:37.9 DEGREE, NAGOYA

J

SITE = J   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE : 1/2) = 1   NUMBER OF DATA POINTS = 16

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	78. 4.14	10.32	864.4	0.27	36.9	12.45	0.0	7.3	28.4	0.18	0.72	1.5	0.0
1	2	78. 4.14	11.37	935.1	0.25	37.0	14.44	0.0	8.3	28.7	0.15	0.77	1.1	0.0
1	3	78. 4.14	12.07	894.6	0.26	37.0	16.15	0.0	8.0	28.5	0.14	0.77	0.6	0.0
1	4	78. 4.14	13.22	818.4	0.27	36.9	18.51	0.0	7.3	28.2	0.12	0.76	1.4	0.0
1	5	78. 4.14	13.52	767.6	0.29	36.9	19.08	0.0	6.0	27.9	0.12	0.76	1.1	0.0
1	6	78. 4.15	11.07	832.4	0.33	36.3	19.80	0.0	6.7	43.5	0.29	0.68	0.8	0.0
1	7	78. 4.15	12.22	812.5	0.34	36.2	22.35	0.0	6.9	43.5	0.26	0.71	1.2	0.0
1	8	78. 4.15	13.22	753.2	0.39	36.2	23.33	0.0	5.9	43.0	0.27	0.69	1.6	0.0
1	9	78. 4.19	10.37	939.4	0.16	37.4	16.86	0.0	6.1	59.8	0.46	0.56	3.0	0.0
1	10	78. 4.19	12.22	967.5	0.18	37.0	19.16	0.0	7.2	60.5	0.43	0.64	1.7	0.0
1	11	78. 4.19	13.22	886.6	0.20	36.9	20.92	0.0	6.5	60.3	0.44	0.63	1.5	0.0
1	12	78. 4.22	10.52	952.0	0.14	38.4	16.76	0.0	5.1	76.6	0.64	0.49	1.7	0.0
1	13	78. 4.22	11.37	983.8	0.14	37.8	18.12	0.0	5.8	77.0	0.60	0.52	1.5	0.0
1	14	78. 4.26	12.07	973.6	0.13	37.8	18.87	0.0	5.8	77.4	0.60	0.53	2.6	0.0
1	15	78. 4.26	12.37	969.4	0.12	37.7	19.68	0.0	5.8	77.4	0.60	0.53	2.6	0.0
1	16	78. 4.26	13.37	874.0	0.12	37.4	20.88	0.0	4.9	76.9	0.64	0.49	2.2	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.0   0.0 *TSTAR

ETA=0.830   -.465*TSTAR   -.091(TSTAR**2)

LEAST SQUARE FIT

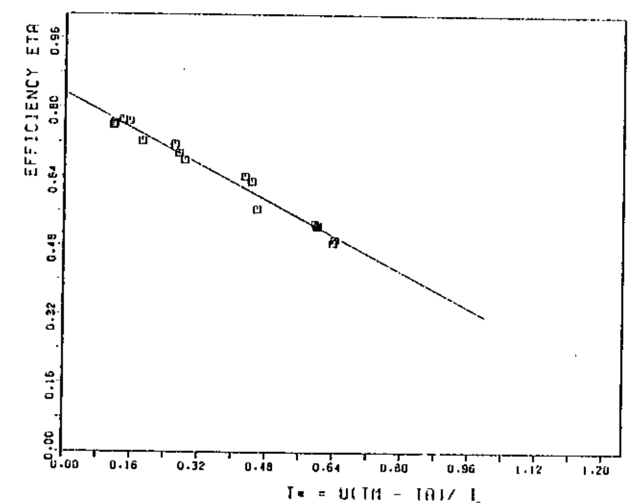
ETA=0.834   -.520*TSTAR

ETA=0.814   -.373*TSTAR   -.193(TSTAR**2)

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ;SITE:JAPAN

REFERENCE AREA: 1.785 M**2; FLUID: WATER;SLOPE:37.9 DEGREE, NAGOYA

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ;SITE:NETHERL.
REFERENCE AREA: 1.791 M**2; FLUID: WATER;SLOPE:45.0 DEGREE, DELFT

NL

SITE = NL   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 7

ID	NO	DATE	HOUR		ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	177. 6. 4	11.30	975.0	0.12	37.4	4.10	0.0	8.1	14.4	0.11	0.73	5.5	0.0
1	2	177. 6. 4	12.30	1008.0	0.12	37.7	5.10	0.0	8.1	22.6	0.17	0.70	5.5	0.0
1	3	177. 6. 4	14.00	1000.0	0.12	38.0	7.40	0.0	7.3	32.8	0.25	0.65	5.5	0.0
1	4	177. 6. 4	14.30	1099.0	0.11	38.6	7.40	0.0	6.8	42.0	0.34	0.60	5.5	0.0
1	5	177. 6. 4	15.00	1025.0	0.12	39.1	8.20	0.0	6.2	56.5	0.47	0.56	5.5	0.0
1	6	177. 6. 4	15.30	1018.0	0.12	38.5	8.00	0.0	5.6	68.8	0.60	0.50	5.5	0.0
1	7	177. 6. 4	16.30	958.0	0.13	38.0	8.10	0.0	4.8	79.3	0.74	0.44	5.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.780 -.480*TSTAR

ETA=0.0 0.0 *TSTAR 0.0 (TSTAR**2)

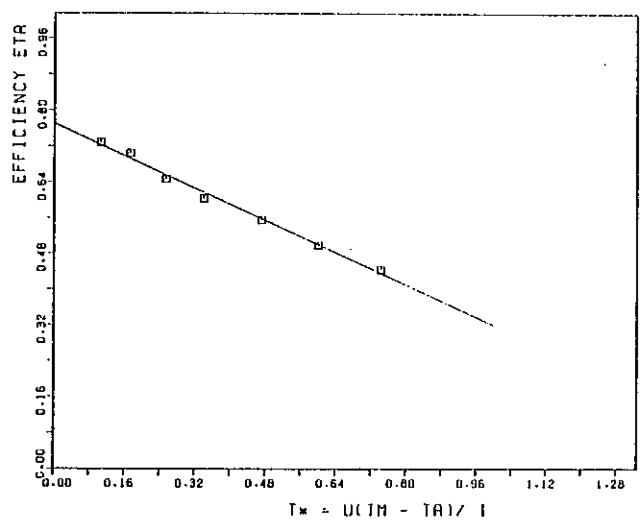
LEAST SQUARE FIT

ETA=0.770 -.451*TSTAR

ETA=0.793 -.597*TSTAR 0.173(TSTAR**2)

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ;SITE:NETHERL.
REFERENCE AREA: 1.791 M**2; FLUID: WATER;SLOPE:45.0 DEGREE, DELFT

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ,SITE:SWEDEN

REFERENCE AREA: 1.78 M**2, FLUID: WATER,SLOPE:45.0 DEGREE. BORAS

S

SITE = S   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/E = 1/2) = 1   NUMBER OF DATA POINTS = 22

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	77. 9.20	15.35	707.0	0.07	37.0	17.90	0.0	4.3	63.5	0.64	0.51	1.5	0.0
1	2	77. 9.20	9.10	770.0	0.05	37.0	13.00	0.0	4.3	63.0	0.65	0.47	1.2	0.0
1	3	77. 9.20	9.25	810.0	0.04	37.0	13.80	0.0	4.6	63.2	0.61	0.48	1.3	0.0
1	4	77. 9.22	13.10	894.0	0.09	37.0	18.00	0.0	5.3	73.2	0.62	0.50	2.2	0.0
1	5	77. 9.22	14.50	801.0	0.09	37.0	16.60	0.0	4.2	72.5	0.70	0.44	2.9	0.0
1	6	77. 9.26	12.35	936.0	0.07	37.0	13.80	0.0	5.3	73.3	0.64	0.48	2.7	0.0
1	7	77. 9.26	13.30	832.0	0.07	37.0	14.20	0.0	4.3	72.8	0.70	0.43	2.5	0.0
1	8	77. 9.26	14.05	794.0	0.07	37.0	14.80	0.0	3.9	72.6	0.73	0.41	2.1	0.0
1	9	77. 9.26	13.30	865.0	0.07	37.0	14.00	0.0	4.6	72.9	0.68	0.44	2.2	0.0
1	10	77. 9.21	10.30	902.0	0.05	37.0	17.50	0.0	7.6	39.2	0.24	0.72	2.1	0.0
1	11	77. 9.21	10.45	923.0	0.05	37.0	17.90	0.0	7.8	39.2	0.23	0.72	1.6	0.0
1	12	77. 9.21	11.00	934.0	0.05	37.0	17.90	0.0	7.9	39.2	0.23	0.72	2.2	0.0
1	13	77. 9.21	11.15	936.0	0.06	37.0	17.80	0.0	7.9	39.2	0.23	0.72	2.2	0.0
1	14	77. 9.22	10.15	866.0	0.08	36.0	16.70	0.0	6.5	49.6	0.38	0.63	1.6	0.0
1	15	77. 9.22	10.30	880.0	0.07	36.0	17.30	0.0	6.4	49.6	0.37	0.62	1.4	0.0
1	16	77. 9.22	10.45	881.0	0.07	37.0	17.60	0.0	6.4	49.6	0.36	0.62	1.6	0.0
1	17	77. 9.22	11.00	880.0	0.08	37.0	18.30	0.0	6.4	49.7	0.36	0.62	1.4	0.0
1	18	77. 9.21	12.30	923.0	0.06	37.0	19.30	0.0	8.6	19.8	0.01	0.80	2.2	0.0
1	19	77. 9.21	12.45	933.0	0.06	37.0	19.30	0.0	8.6	19.8	0.00	0.79	2.3	0.0
1	20	77. 9.21	13.00	938.0	0.07	37.0	19.10	0.0	8.6	19.8	0.01	0.79	2.5	0.0
1	21	77. 9.21	13.15	936.0	0.07	37.0	19.30	0.0	8.6	19.8	0.01	0.79	2.3	0.0
1	22	77. 9.21	13.30	934.0	0.08	37.0	19.30	0.0	8.6	19.8	0.01	0.79	2.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

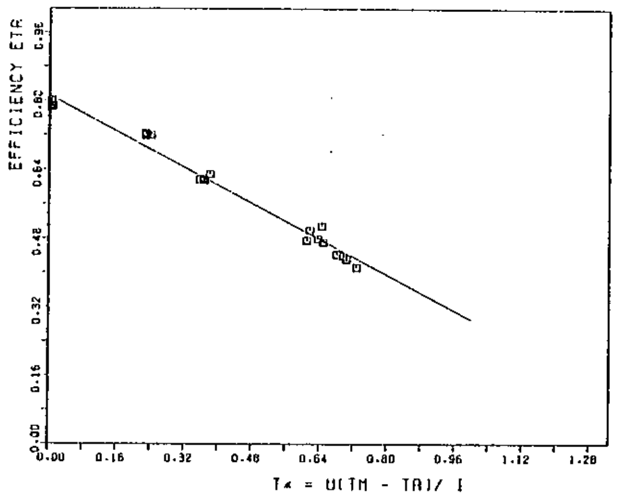
ETA=0.0   0.0 *TSTAR

ETA=0.802   -.344*TSTAR   -.251(TSTAR**2)

LEAST SQUARE FIT

ETA=0.811   -.520*TSTAR

ETA=0.797   -.346*TSTAR   -.242(TSTAR**2)



COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ;SITE:USA

REFERENCE AREA: 1.79 M**2; FLUID: WATER;SLOPE:VARIABLE, PHOENIX

USA

SITE = USA   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 20

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	76. 8.31	9.43	990.0	0.04	35.8	33.70	0.0	9.8	37.8	0.04	0.84	2.2	0.0
1	2	76. 8.31	9.58	999.0	0.04	35.7	32.80	0.0	10.0	37.5	0.05	0.84	3.1	0.0
1	3	76. 8.31	10.37	1013.0	0.03	35.0	33.50	0.0	8.8	62.7	0.29	0.71	3.1	0.0
1	4	76. 8.31	10.52	1013.0	0.03	34.9	33.10	0.0	8.8	62.7	0.29	0.71	4.5	0.0
1	5	76. 8.31	11.42	1017.0	0.03	35.1	33.90	0.0	7.6	81.1	0.46	0.62	0.9	0.0
1	6	76. 8.31	11.57	1016.0	0.03	35.2	33.78	0.0	7.6	81.1	0.47	0.62	1.8	0.0
1	7	76. 8.31	12.37	1015.0	0.04	35.0	33.28	0.0	6.5	95.8	0.62	0.53	4.5	0.0
1	8	76. 8.31	12.52	1012.0	0.04	34.9	33.94	0.0	6.4	96.1	0.61	0.53	2.2	0.0
1	9	76. 8.31	13.07	1012.0	0.04	34.6	33.61	0.0	6.6	96.1	0.62	0.54	1.3	0.0
1	10	76. 8.31	13.22	1008.0	0.04	34.5	33.73	0.0	6.7	96.2	0.62	0.54	2.7	0.0
1	11	76. 8.31	14.02	1008.0	0.04	35.4	34.22	0.0	7.8	80.6	0.46	0.64	4.9	0.0
1	12	76. 8.31	14.17	1004.0	0.04	35.8	34.33	0.0	7.7	80.3	0.46	0.64	4.9	0.0
1	13	76. 8.31	14.52	984.1	0.05	36.2	34.50	0.0	8.4	61.6	0.28	0.71	4.9	0.0
1	14	76. 8.31	15.07	1019.0	0.01	36.3	34.22	0.0	8.6	61.2	0.26	0.71	4.5	0.0
1	15	76. 9. 1	12.23	1006.0	0.04	34.9	36.17	0.0	5.7	108.8	0.72	0.47	0.9	0.0
1	16	76. 9. 1	12.38	1006.0	0.04	34.9	36.61	0.0	5.6	108.6	0.72	0.46	1.3	0.0
1	17	76. 9. 1	12.53	1010.0	0.04	34.5	36.78	0.0	5.7	108.8	0.71	0.46	3.1	0.0
1	18	76. 9. 1	13.08	1011.0	0.04	34.4	36.83	0.0	5.6	108.8	0.71	0.45	3.6	0.0
1	19	76. 9. 1	13.52	1002.0	0.05	35.3	37.00	0.0	10.0	42.6	0.06	0.83	4.5	0.0
1	20	76. 9. 1	14.07	996.7	0.05	35.4	38.00	0.0	9.0	42.1	0.04	0.83	2.7	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.0   0.0 *TSTAR

ETA=0.0   0.0 *TSTAR   0.0 (TSTAR**2)

LEAST SQUARE FIT

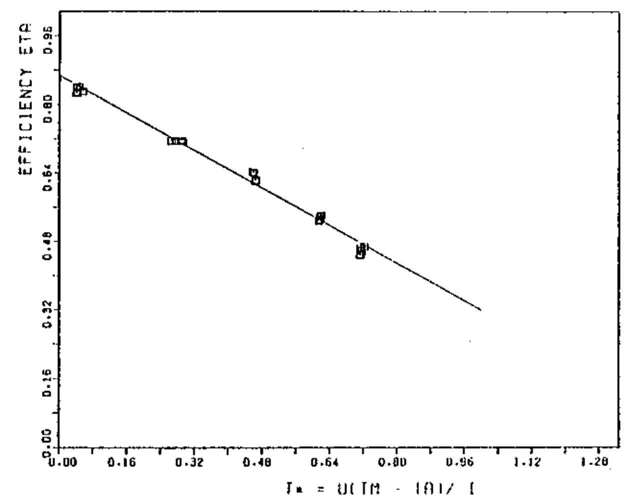
ETA=0.868   -.549*TSTAR

ETA=0.851   -.394*TSTAR   -.203(TSTAR**2)

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : NBS/ASHRAE ;SITE:USA

REFERENCE AREA: 1.79 M**2; FLUID: WATER;SLOPE:VARIABLE, PHOENIX

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



APPENDIX D

Data: IEA-2 Collector
NBS Procedure

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE ; SITE:AUSTRIA

REFERENCE AREA: 2.32 M**2; FLUID:WATER ; SLOPE: 38/47 DEGREE.INNSBRUCK

A

SITE = A   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 22

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	77. 4.29	10.30	953.0	0.0	36.9	17.20	0.0	8.6	22.3	0.05	0.58	4.5	0.0
1	2	77. 5. 1	13.57	160.0	0.0	37.0	11.70	0.0	0.9	26.0	0.89	0.37	0.5	0.0
1	3	77. 4.29	11.11	996.0	0.0	36.9	15.00	0.0	7.4	35.6	0.21	0.48	4.5	0.0
1	4	77. 4.29	13.00	953.0	0.0	36.8	18.00	0.0	6.5	44.0	0.29	0.47	4.5	0.0
1	5	77. 4.29	12.02	720.0	0.0	36.9	16.90	0.0	4.1	53.0	0.50	0.37	4.5	0.0
1	6	77. 4.29	14.02	780.0	0.0	36.9	21.60	0.0	4.3	77.1	0.71	0.35	1.5	0.0
1	7	77. 5. 4	12.29	1018.0	0.0	36.7	20.10	0.0	5.7	81.9	0.61	0.35	1.5	0.0
1	8	77. 5. 4	13.59	780.0	0.0	36.7	17.30	0.0	4.9	37.6	0.26	0.31	1.5	0.0
2	9	77. 5. 3	12.52	894.0	0.0	75.8	21.30	0.0	3.3	42.4	0.24	0.43	2.0	0.0
2	10	77. 6.12	13.48	854.0	0.0	77.8	21.40	0.0	2.8	49.1	0.32	0.39	2.0	0.0
2	11	77. 6.12	14.25	591.0	0.0	76.8	22.20	0.0	2.3	45.4	0.39	0.46	2.0	0.0
2	12	77. 6.13	12.44	831.0	0.0	76.2	15.70	0.0	2.7	43.4	0.33	0.38	2.0	0.0
2	13	77. 6.13	13.20	832.0	0.0	76.8	16.60	0.0	2.7	43.7	0.33	0.38	2.0	0.0
2	14	77. 6.13	14.09	861.0	0.0	77.7	17.40	0.0	2.7	46.4	0.33	0.37	2.0	0.0
2	15	77. 6.14	12.09	974.0	0.0	80.1	17.80	0.0	2.9	45.3	0.28	0.36	2.0	0.0
2	16	77. 6.14	12.45	976.0	0.0	80.6	18.90	0.0	3.0	51.8	0.34	0.39	2.0	0.0
2	17	77. 6.14	13.51	875.0	0.0	80.6	19.20	0.0	2.5	53.9	0.39	0.36	2.0	0.0
2	18	77. 6.19	11.15	930.0	0.0	82.0	22.50	0.0	2.3	66.0	0.47	0.32	1.0	0.0
2	19	77. 6.19	12.00	957.0	0.0	83.7	23.60	0.0	2.4	72.5	0.51	0.34	1.0	0.0
2	20	77. 6.19	12.30	974.0	0.0	85.0	23.40	0.0	2.3	76.8	0.55	0.32	1.0	0.0
2	21	77. 6.19	13.14	1032.0	0.0	84.8	23.50	0.0	2.1	79.2	0.54	0.28	1.0	0.0
2	22	77. 6.20	1. 44	1010.0	0.0	81.7	15.80	0.0	2.6	65.9	0.45	0.33	2.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.550 0.371*TSTAR

ETA=0.550 0.371*TSTAR 0.077(TSTAR**2)

LEAST SQUARE FIT

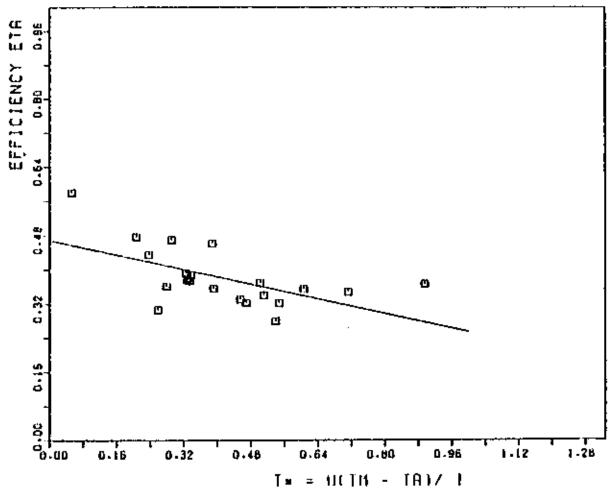
ETA=0.459 -.215*TSTAR

ETA=0.604 -.897*TSTAR 0.722(TSTAR**2)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE ; SITE:AUSTRIA

REFERENCE AREA: 2.32 M**2; FLUID:WATER ; SLOPE: 38/47 DEGREE.INNSBRUCK

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : NBS/ASHRAE ,SITE:BELGIUM

REFERENCE AREA: 2.30 M**2, FLUID: H2O , SLOPE: 50 DEGREE.HEVERLEE

B

SITE = ' 8 COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1 NUMBER OF DATA POINTS = 68

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	77. 7. 4	9.30	626.0	0.0	27.2	23.10	0.0	5.2	42.5	0.31	0.41	2.0	0.0
1	2	77. 7. 4	9.50	660.0	0.0	25.0	24.10	0.0	6.1	43.1	0.29	0.42	2.0	0.0
1	3	77. 7. 4	10.10	706.0	0.0	23.6	24.40	0.0	7.6	43.8	0.27	0.46	2.0	0.0
1	4	77. 7. 4	10.30	764.0	0.0	22.9	25.20	0.0	8.4	44.7	0.25	0.46	2.0	0.0
1	5	77. 7. 4	10.50	769.0	0.0	21.8	25.40	0.0	9.5	45.6	0.26	0.49	2.0	0.0
1	6	77. 7. 4	11.10	824.0	0.0	21.1	26.10	0.0	10.7	46.9	0.25	0.50	2.0	0.0
1	7	77. 7. 4	11.30	827.0	0.0	20.1	26.70	0.0	10.9	47.2	0.25	0.48	2.0	0.0
1	8	77. 7. 4	11.50	855.0	0.0	19.4	27.00	0.0	11.8	48.4	0.25	0.49	2.0	0.0
1	9	77. 7. 4	12.10	826.0	0.0	19.0	28.00	0.0	11.2	49.4	0.26	0.47	2.0	0.0
1	10	77. 7. 4	12.30	856.0	0.0	18.7	28.60	0.0	11.2	49.4	0.24	0.45	2.0	0.0
1	11	77. 7. 4	12.50	839.0	0.0	18.4	28.70	0.0	11.8	49.4	0.25	0.47	2.0	0.0
1	12	77. 7. 4	13.10	871.0	0.0	18.4	28.90	0.0	12.7	51.3	0.25	0.49	2.0	0.0
1	13	77. 7. 4	13.50	792.0	0.0	16.9	30.40	0.0	11.5	51.3	0.26	0.45	2.0	0.0
1	14	77. 7. 4	14.30	674.0	0.0	16.1	30.70	0.0	10.3	52.2	0.32	0.45	2.0	0.0
1	15	77. 7. 5	10.30	768.0	0.25	34.4	26.60	0.0	3.0	75.6	0.64	0.25	2.0	0.0
1	16	77. 7. 5	10.50	800.0	0.27	36.9	27.00	0.0	2.9	76.9	0.62	0.25	2.0	0.0
1	17	77. 7. 5	11.10	832.0	0.22	39.4	27.50	0.0	3.0	76.9	0.59	0.26	2.0	0.0
1	18	77. 7. 5	11.30	864.0	0.20	36.7	27.90	0.0	3.1	80.6	0.61	0.24	2.0	0.0
1	19	77. 7. 5	11.50	848.0	0.23	39.2	27.70	0.0	3.1	81.9	0.64	0.26	2.0	0.0
1	20	77. 7. 5	12.10	848.0	0.24	38.1	29.40	0.0	3.5	82.8	0.63	0.28	2.0	0.0
1	21	77. 7. 5	12.30	880.0	0.30	37.2	29.50	0.0	3.3	84.1	0.62	0.25	2.0	0.0
1	22	77. 7. 5	13.30	800.0	0.29	28.1	29.70	0.0	6.2	66.3	0.46	0.40	2.0	0.0
1	23	77. 7. 5	13.50	768.0	0.31	30.8	30.30	0.0	5.0	64.4	0.44	0.37	2.0	0.0
1	24	77. 7. 5	14.10	752.0	0.33	29.7	30.20	0.0	4.9	62.5	0.43	0.35	2.0	0.0
1	25	77. 7. 5	14.30	656.0	0.46	29.7	30.50	0.0	4.3	61.9	0.48	0.39	2.0	0.0
1	26	77. 7. 5	14.50	688.0	0.57	31.4	28.90	0.0	4.0	62.5	0.49	0.33	2.0	0.0
1	27	77. 7. 6	9.50	704.0	0.27	16.6	24.50	0.0	9.2	46.9	0.32	0.40	2.0	0.0
1	28	77. 7. 6	10.30	768.0	0.29	12.9	25.80	0.0	14.0	49.7	0.31	0.43	2.0	0.0
1	29	77. 7. 6	10.50	832.0	0.23	12.4	25.90	0.0	15.0	50.3	0.29	0.41	2.0	0.0
1	30	77. 7. 6	11.10	816.0	0.[illegible]5	11.4	26.80	0.0	17.9	52.2	0.31	0.46	2.0	0.0
1	31	77. 7. 6	11.30	872.0	0.28	10.6	27.10	0.0	18.3	51.6	0.28	0.41	2.0	0.0
1	32	77. 7.12	9.50	616.0	0.49	58.3	22.00	0.0	2.4	43.8	0.35	0.41	2.0	0.0
1	33	77. 7.12	10.10	664.0	0.46	58.6	22.50	0.0	2.6	43.8	0.32	0.42	2.0	0.0
1	34	77. 7.12	10.30	704.0	0.43	27.1	22.70	0.0	6.8	44.4	0.31	0.48	2.0	0.0
1	35	77. 7.12	10.50	728.0	0.44	24.0	23.30	0.0	8.1	45.3	0.30	0.49	2.0	0.0
1	36	77. 7.12	11.10	752.0	0.40	22.8	24.10	0.0	9.0	46.2	0.29	0.50	2.0	0.0
1	37	77. 7.12	11.50	792.0	0.38	20.9	25.30	0.0	10.2	48.1	0.29	0.49	2.0	0.0
1	38	77. 7.12	12.10	776.0	0.39	20.3	25.80	0.0	10.5	48.4	0.29	0.50	2.0	0.0
1	39	77. 7.12	12.30	776.0	0.40	19.8	27.10	0.0	10.6	46.9	0.25	0.49	2.0	0.0
1	40	77. 7.12	12.50	760.0	0.46	83.6	28.10	0.0	2.3	47.5	0.26	0.47	2.0	0.0
1	41	77. 7.12	13.10	760.0	0.51	83.6	28.00	0.0	2.3	48.1	0.26	0.46	2.0	0.0
1	42	77. 7.12	13.30	736.0	0.62	86.1	28.60	0.0	2.2	48.1	0.27	0.47	2.0	0.0
1	43	77. 7.12	13.50	688.0	0.72	83.9	29.30	0.0	2.1	48.8	0.28	0.46	2.0	0.0
1	44	77. 7.12	14.10	672.0	0.78	83.9	29.70	0.0	1.9	48.8	0.28	0.44	2.0	0.0
1	45	77. 7.12	14.30	640.0	0.87	83.9	29.60	0.0	1.8	48.8	0.30	0.43	2.0	0.0
1	46	77. 8. 5	10.05	736.0	0.17	65.0	21.10	0.0	3.0	32.5	0.15	0.48	2.0	0.0
1	47	77. 8. 5	10.25	800.0	0.14	65.0	21.30	0.0	3.1	34.0	0.16	0.47	2.0	0.0
1	48	77. 8. 5	10.45	848.0	0.12	62.5	21.70	0.0	3.4	35.6	0.16	0.46	2.0	0.0
1	49	77. 8. 5	11.05	880.0	0.14	63.9	22.70	0.0	3.6	37.5	0.17	0.48	2.0	0.0
1	50	77. 8. 5	11.25	896.0	0.12	63.3	22.90	0.0	3.6	38.8	0.18	0.46	2.0	0.0
1	51	77. 8. 5	11.45	896.0	0.12	62.8	23.10	0.0	3.8	40.6	0.20	0.48	2.0	0.0
1	52	77. 8. 5	12.05	904.0	0.12	62.8	24.10	0.0	3.8	42.5	0.20	0.48	2.0	0.0
1	53	77. 8. 5	12.25	912.0	0.10	62.8	23.90	0.0	3.8	43.7	0.22	0.48	2.0	0.0
1	54	77. 8. 5	12.45	912.0	0.10	62.8	24.00	0.0	3.7	45.0	0.23	0.47	2.0	0.0
1	55	77. 8. 5	13.05	896.0	0.09	64.7	24.60	0.0	3.7	45.2	0.23	0.49	2.0	0.0
1	56	77. 8. 5	13.25	864.0	0.13	64.4	25.10	0.0	3.6	46.2	0.24	0.49	2.0	0.0

B

1	57	177.	8.	51	13.45	832.0	0.22	64.4	23.80	0.0	3.4	46.2	0.27	0.49	2.0	0.0
:	58	177.	8.	51	14.05	816.0	0.33	64.4	24.10	0.0	3.3	46.2	0.27	0.47	2.0	0.0
1	59	177.	8.	51	14.25	768.0	0.47	64.7	25.10	0.0	3.0	46.2	0.27	0.47	2.0	0.0
1	60	177.	8.	51	14.45	704.0	0.62	63.1	23.50	0.0	2.9	46.2	0.32	0.50	2.0	0.0
1	61	177.	9.13		9.30	768.0	0.17	44.2	13.20	0.0	4.7	24.0	0.14	0.49	2.0	0.0
1	62	177.	9.14		10.50	780.0	0.24	42.8	16.60	0.0	5.0	29.4	0.16	0.50	2.0	0.0
1	63	177.	9.14		11.10	825.0	0.19	42.5	17.50	0.0	5.3	31.3	0.17	0.49	2.0	0.0
1	64	177.	9.14		11.30	800.0	0.17	41.1	17.30	0.0	5.3	32.5	0.19	0.50	2.0	0.0
1	65	177.	9.14		13.00	810.0	0.32	38.9	18.20	0.0	5.6	38.8	0.25	0.49	2.0	0.0
1	66	177.	9.19		10.00	784.0	0.0	46.7	15.00	0.0	4.8	21.1	0.10	0.52	2.0	0.0
1	67	177.	9.19		13.00	848.0	0.0	41.9	17.50	0.0	6.1	20.0	0.03	0.55	2.0	0.0
1	68	177.	9.19		13.30	808.0	0.0	40.8	17.50	0.0	6.0	20.0	0.03	0.56	2.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.0 0.0 *TSTAR

ETA=0.504 0.228*TSTAR 0.033(TSTAR**2)

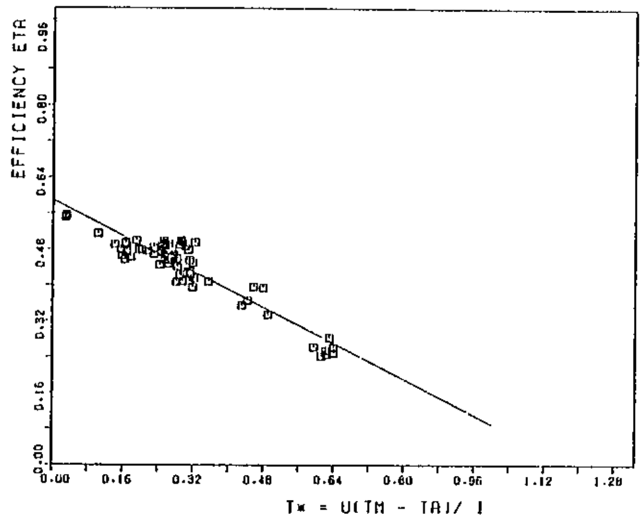
LEAST SQUARE FIT

ETA=0.590 -.500*TSTAR

ETA=0.533 -.128*TSTAR -.500(TSTAR**2)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE ;SITE:BELGIUM
REFERENCE AREA: 2.30 M**2; FLUID: H2O ; SLOPE: 50 DEGREE.HEVERLEE

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : NBS/ASHRAE ,SITE:BELGIUM

REFERENCE AREA: 2.30 M**2, FLUID: H2O , SLOPE: 35 DEGREE. MONS

B

SITE = 8 COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/DSE = 1/2) = 1 NUMBER OF DATA POINTS = 38

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
	1	77. 5.18	13.00	761.0	0.18	34.2	19.70	0.0	6.3	40.4	0.27	0.51	0.3	0.0
	2	77. 5.18	14.00	762.0	0.19	34.2	19.00	0.0	6.3	41.8	0.29	0.52	0.3	0.0
	3	77. 5.24	12.06	756.0	0.0	34.2	23.10	0.0	5.4	52.3	0.41	0.45	0.3	0.0
	4	77. 5.24	13.18	774.0	0.0	34.2	22.60	0.0	5.9	50.4	0.36	0.48	0.3	0.0
	5	77. 5.25	12.18	753.0	0.0	34.2	24.20	0.0	5.4	54.8	0.41	0.45	0.3	0.0
	6	77. 5.25	12.54	768.0	0.0	34.2	25.90	0.0	5.7	54.8	0.38	0.47	0.2	0.0
	7	77. 5.25	13.30	831.0	0.0	34.2	27.30	0.0	6.4	55.0	0.33	0.48	0.1	0.0
	8	77. 5.26	11.00	708.0	0.0	34.2	21.80	0.0	3.5	61.1	0.56	0.31	0.3	0.0
	9	77. 5.26	11.36	748.0	0.0	34.2	22.70	0.0	4.7	59.8	0.50	0.39	0.2	0.0
	10	77. 5.26	12.06	781.0	0.0	34.2	22.60	0.0	5.1	57.9	0.45	0.41	0.3	0.0
	11	77. 5.26	12.44	795.0	0.0	34.2	22.60	0.0	5.0	56.6	0.43	0.40	0.3	0.0
	12	77. 5.27	11.00	737.0	0.0	34.2	17.30	0.0	2.9	66.8	0.67	0.25	0.3	0.0
	13	77. 5.27	13.18	862.0	0.0	34.2	19.20	0.0	4.4	65.6	0.54	0.32	0.4	0.0
	14	77. 5.28	11.00	72.5	0.0	34.2	20.90	0.0	2.7	72.1	0.71	0.23	0.2	0.0
	15	77. 5.28	11.35	77.4	0.0	34.2	21.50	0.0	3.2	73.8	0.68	0.26	0.2	0.0
	16	77. 5.28	12.10	816.0	0.0	34.2	21.80	0.0	3.6	75.5	0.65	0.27	0.2	0.0
	17	77. 5.28	13.20	846.0	0.0	34.2	22.60	0.0	3.6	78.1	0.65	0.26	0.2	0.0
	18	77. 5.29	11.02	685.0	0.0	34.2	22.20	0.0	2.3	73.5	0.75	0.21	0.2	0.0
	19	77. 5.29	11.36	737.0	0.0	34.2	21.70	0.0	2.6	74.9	0.72	0.22	0.3	0.0
	20	77. 5.29	12.10	764.0	0.0	34.2	23.10	0.0	2.9	76.9	0.70	0.24	0.2	0.0
	21	77. 6.13	12.10	795.0	0.0	34.2	31.20	0.0	7.2	40.0	0.11	0.57	0.2	0.0
	22	77. 6.13	12.38	802.0	0.0	34.2	31.80	0.0	7.3	42.4	0.13	0.57	0.3	0.0
	23	77. 6.13	13.18	842.0	0.0	34.2	32.10	0.0	7.6	44.4	0.15	0.56	0.2	0.0
	24	77. 7. 4	13.16	782.0	0.28	34.2	29.30	0.0	6.9	42.4	0.17	0.55	0.2	0.0
	25	77. 7. 5	11.36	724.0	0.14	34.2	26.20	0.0	6.3	38.6	0.17	0.54	0.3	0.0
	26	77. 7. 5	12.10	758.0	0.20	34.2	26.90	0.0	6.5	40.6	0.18	0.53	0.2	0.0
	27	77. 7. 5	12.44	782.0	0.24	34.2	27.80	0.0	6.8	42.6	0.19	0.54	0.2	0.0
	28	77. 7. 6	11.02	624.0	0.17	34.2	25.60	0.0	4.7	43.4	0.29	0.47	0.3	0.0
	29	77. 7. 6	11.52	683.0	0.27	34.2	26.90	0.0	5.4	45.4	0.27	0.49	0.2	0.0
	30	77. 7. 6	13.12	821.0	0.17	34.2	28.20	0.0	6.8	48.8	0.25	0.51	0.2	0.0
	31	77. 7.12	11.16	638.0	0.0	34.2	23.40	0.0	4.6	47.0	0.37	0.45	0.1	0.0
	32	77. 7.12	11.50	687.0	0.0	34.2	25.50	0.0	5.2	48.2	0.33	0.47	0.1	0.0
	33	77. 7.12	12.24	731.0	0.0	34.2	27.40	0.0	5.7	49.4	0.30	0.48	0.1	0.0
	34	77. 7.12	12.58	748.0	0.0	34.2	28.60	0.0	5.9	50.6	0.29	0.49	0.1	0.0
	35	77. 9. 2	11.50	747.0	0.01	34.2	20.60	0.0	6.7	39.1	0.24	0.54	0.1	0.0
	36	77. 9. 2	12.14	812.0	0.02	34.2	21.10	0.0	7.0	42.6	0.26	0.54	0.1	0.0
	37	77. 9. 4	11.06	663.0	0.0	34.2	20.40	0.0	5.7	33.9	0.20	0.54	0.4	0.0
	38	77. 9. 4	11.30	738.0	0.03	34.2	21.40	0.0	6.3	37.3	0.21	0.53	0.4	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

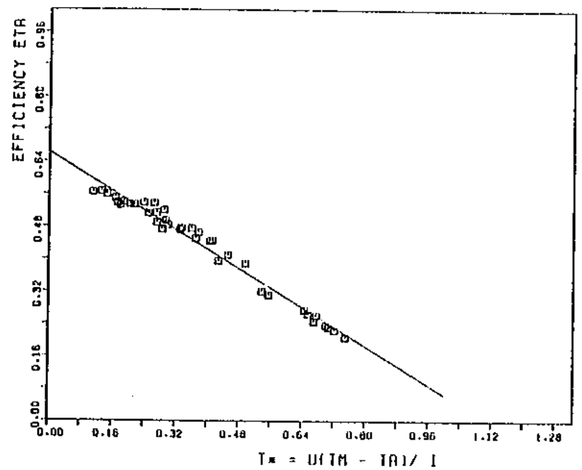
ETA=0.0 0.0 *TSTAR

ETA=0.560 0.264*TSTAR 0.327(TSTAR**2)

LEAST SQUARE FIT

ETA=0.664 -.590*TSTAR

ETA=0.611 -.291*TSTAR -.353(TSTAR**2)



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : NBS/ASHRAE , SITE:GERMANY

REFERENCE AREA: 2.30 M**2, FLUID:WATER , SLOPE: 45 DEGREE. JUELICH

D

SITE - D COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1 NUMBER OF DATA POINTS = 21

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
	1	77. 9.27	12.00	878.0	0.28	17.2	18.50	22.5	14.1	29.6	0.13	0.52	1.5	0.0
	2	77. 9.27	0.0	894.0	0.0	17.5	18.80	23.1	14.2	30.2	0.13	0.52	1.5	0.0
	3	77. 9.27	13.10	852.0	0.0	17.4	19.70	23.6	13.8	30.5	0.13	0.53	1.5	0.0
	4	77. 9.24	13.00	891.0	0.0	13.2	17.00	35.2	15.9	43.1	0.29	0.44	1.5	0.0
	5	77. 9.24	0.0	876.0	0.0	14.8	17.40	35.2	14.3	42.3	0.28	0.45	1.5	0.0
	6	77. 9.24	0.0	836.0	0.0	15.2	17.50	48.9	10.9	54.4	0.44	0.37	1.5	0.0
	7	77. 9.24	0.0	819.0	0.0	15.5	17.50	48.9	10.9	54.4	0.45	0.38	1.5	0.0
	8	77. 9.24	0.0	807.0	0.0	15.5	17.50	48.9	10.9	54.4	0.46	0.39	1.5	0.0
	9	77. 9.24	15.20	740.0	0.0	15.9	17.50	63.2	7.7	67.1	0.67	0.31	1.5	0.0
	10	77. 9.27	14.00	800.0	0.0	17.4	19.90	64.7	7.7	68.6	0.61	0.31	1.5	0.0
	11	77. 9.27	15.00	658.0	0.0	17.2	20.20	80.5	4.0	82.5	0.95	0.20	1.5	0.0
	12	77.10.12	12.45	857.0	0.0	16.3	17.50	80.1	7.5	83.8	0.77	0.27	1.5	0.0
	13	77.10.12	0.0	857.0	0.0	16.2	17.50	80.1	7.3	83.8	0.77	0.26	1.5	0.0
	14	77.10.12	0.0	777.0	0.0	16.6	17.70	89.5	4.2	91.6	0.95	0.17	1.5	0.0
	15	77.10.12	0.0	756.0	0.0	16.6	17.70	89.5	3.9	91.5	0.98	0.16	1.5	0.0
	16	77.10.12	15.15	728.0	0.0	16.8	17.70	89.4	3.7	91.3	1.01	0.16	1.5	0.0
	17	78.10.12	9.30	661.0	0.0	41.4	13.50	35.5	3.7	37.4	0.36	0.43	1.5	0.0
	18	78.10.12	10.10	755.0	0.0	41.4	15.30	35.0	4.4	37.2	0.29	0.44	1.5	0.0
	19	78.10.12	11.50	838.0	0.0	41.7	18.50	59.3	3.9	61.2	0.51	0.35	1.5	0.0
	20	78.10.12	12.10	854.0	0.0	41.7	18.90	59.3	4.2	61.4	0.50	0.37	1.5	0.0
	21	78.10.12	14.30	769.0	0.0	43.4	21.00	88.0	1.9	88.9	0.88	0.20	1.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.570 0.410*TSTAR

ETA=0.0 0.0 *TSTAR 0.0 (TSTAR**2)

LEAST SQUARE FIT

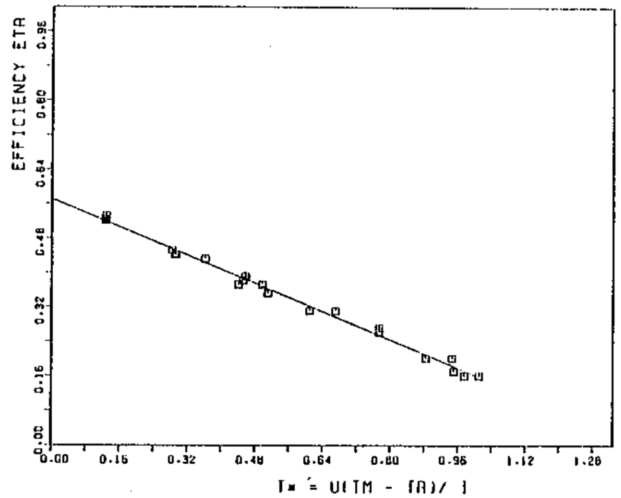
ETA=0.571 -.409*TSTAR

ETA=0.576 -.431*TSTAR 0.019(TSTAR**2)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE : SITE:GERMANY

REFERENCE AREA: 2.30 M**2: FLUID:WATER : SLOPE: 45 DEGREE. JUELICH

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE ; SITE:GERMANY

REFERENCE AREA: 2.30 M**2; FLUID:WATER ; SLOPE: VARIABLE. HEIDELBERG

D

SITE = D　　COLLECTOR TYPE IEA- 2　　TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1　　NUMBER OF DATA POINTS = 14

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	0. 0. 0	0.0	945.0	0.0	11.4	24.40	0.0	22.7	37.2	0.14	0.49	0.0	0.0
1	2	0. 0. 0	0.0	792.0	0.0	11.3	27.50	0.0	18.9	35.3	0.10	0.48	0.0	0.0
1	3	0. 0. 0	0.0	773.0	0.0	11.1	28.80	0.0	18.7	35.2	0.08	0.48	0.0	0.0
1	4	0. 0. 0	0.0	665.0	0.0	11.1	28.50	0.0	16.0	34.3	0.09	0.50	0.0	0.0
1	5	0. 0. 0	0.0	690.0	0.0	10.9	29.00	0.0	17.7	34.8	0.08	0.50	0.0	0.0
1	6	0. 0. 0	0.0	816.0	0.0	20.7	23.70	0.0	9.4	54.6	0.38	0.43	0.0	0.0
1	7	0. 0. 0	0.0	841.0	0.0	20.5	24.70	0.0	8.3	64.1	0.47	0.38	0.0	0.0
1	8	0. 0. 0	0.0	893.0	0.0	20.1	27.80	0.0	8.3	74.1	0.52	0.33	0.0	0.0
1	9	0. 0. 0	0.0	883.0	0.0	19.8	28.30	0.0	7.2	83.2	0.62	0.29	0.0	0.0
1	10	0. 0. 0	0.0	930.0	0.0	23.1	31.00	0.0	5.5	93.7	0.67	0.24	0.0	0.0
1	11	0. 0. 0	0.0	895.0	0.0	22.3	28.00	0.0	6.9	72.9	0.50	0.30	0.0	0.0
1	12	0. 0. 0	0.0	925.0	0.0	22.1	28.90	0.0	9.5	57.3	0.31	0.40	0.0	0.0
1	13	0. 0. 0	0.0	915.0	0.0	21.9	27.60	0.0	7.1	73.1	0.50	0.30	0.0	0.0
1	14	0. 0. 0	0.0	880.0	0.0	23.5	28.40	0.0	5.0	92.9	0.73	0.23	0.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.0　　0.0 *TSTAR

ETA=0.530　　0.303*TSTAR　　0.147(TSTAR**2)

LEAST SQUARE FIT

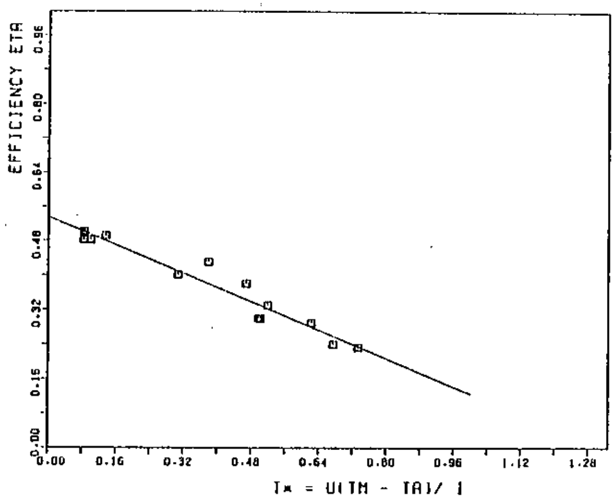
ETA=0.536　　-.410*TSTAR

ETA=0.522　　-.289*TSTAR　　-.164(TSTAR**2)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE ; SITE:GERMANY

REFERENCE AREA: 2.30 M**2; FLUID:WATER ; SLOPE: VARIABLE. HEIDELBERG

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : NBS/ASHRAE , SITE:GERMANY

REFERENCE AREA: 2.303 M**2, FLUID:WATER , SLOPE: 48.5. STUTTGART

D̄

SITE = D   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 32

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
	1	78. 5.27	10.33	788.6	0.27	36.4	19.81	0.0	4.0	58.1	0.49	0.34	0.0	0.0
	2	78. 5.27	10.58	857.6	0.26	36.1	19.64	0.0	4.8	58.2	0.45	0.37	0.0	0.0
	3	78. 5.28	10.19	747.3	0.26	35.8	20.94	0.0	4.2	58.1	0.50	0.37	0.0	0.0
	4	78. 5.28	10.54	820.4	0.29	36.1	21.16	0.0	4.8	58.4	0.45	0.39	0.0	0.0
	5	78. 5.29	9.47	652.0	0.31	35.7	22.00	0.0	3.2	57.6	0.55	0.32	0.0	0.0
	6	78. 5.29	10.59	810.5	0.30	35.6	22.78	0.0	5.0	58.4	0.44	0.40	0.0	0.0
	7	78. 5.30	9.42	648.8	0.24	34.8	24.26	0.0	2.7	67.1	0.66	0.27	0.0	0.0
	8	78. 5.30	10.10	718.7	0.29	34.8	23.61	0.0	3.3	67.6	0.61	0.30	0.0	0.0
	9	78. 5.30	11.57	913.9	0.20	34.9	24.28	0.0	5.0	67.2	0.47	0.35	0.0	0.0
	10	78. 5.30	13.10	895.0	0.21	34.8	24.51	0.0	5.2	68.1	0.49	0.37	0.0	0.0
	11	78. 5.31	10.13	733.7	0.28	35.3	21.45	0.0	2.7	65.7	0.60	0.24	0.0	0.0
	12	78. 5.31	10.57	823.2	0.21	35.2	22.34	0.0	4.3	67.4	0.55	0.33	0.0	0.0
	13	78. 5.31	12.14	889.2	0.21	35.3	23.33	0.0	5.1	66.8	0.49	0.37	0.0	0.0
	14	78. 5.31	13.44	819.9	0.23	35.5	24.11	0.0	4.5	67.6	0.53	0.35	0.0	0.0
	15	78. 5.31	14.52	681.1	0.25	35.4	26.75	0.0	3.3	67.3	0.60	0.31	0.0	0.0
	16	78. 6. 1	10.34	714.6	0.30	33.2	23.48	0.0	2.1	85.4	0.87	0.17	0.0	0.0
	17	78. 6. 1	11.21	752.5	0.33	33.0	24.84	0.0	2.4	85.9	0.81	0.19	0.0	0.0
	18	78. 6. 1	12.00	866.2	0.24	33.0	25.70	0.0	3.6	86.1	0.70	0.25	0.0	0.0
	19	78. 6. 1	13.01	811.2	0.25	33.7	26.51	0.0	3.3	85.8	0.73	0.25	0.0	0.0
	20	78. 6. 2	10.03	668.4	0.31	36.3	26.42	0.0	4.8	38.8	0.19	0.48	0.0	0.0
	21	78. 6. 2	11.09	749.4	0.29	36.9	27.76	0.0	6.8	34.9	0.09	0.57	0.0	0.0
	22	78. 6. 2	12.05	865.2	0.27	37.0	27.09	0.0	7.4	35.2	0.09	0.57	0.0	0.0
	23	78. 6. 2	12.51	842.4	0.27	36.9	28.74	0.0	7.3	35.3	0.08	0.59	0.0	0.0
	24	78. 6. 2	14.02	800.1	0.31	36.8	28.38	0.0	7.0	35.0	0.08	0.59	0.0	0.0
	25	78. 6. 3	10.20	738.5	0.23	35.2	28.48	0.0	6.6	31.6	0.04	0.58	0.0	0.0
	26	78. 6. 3	11.30	856.1	0.20	35.3	27.96	0.0	7.7	31.6	0.04	0.58	0.0	0.0
	27	78. 6. 3	12.10	886.4	0.21	35.3	28.24	0.0	7.9	30.2	0.02	0.58	0.0	0.0
	28	78. 6. 4	10.05	693.2	0.27	35.5	26.73	0.0	5.8	32.4	0.08	0.54	0.0	0.0
	29	78. 6. 4	10.52	785.3	0.25	35.4	26.74	0.0	6.8	32.8	0.08	0.56	0.0	0.0
	30	78. 6. 4	11.41	833.9	0.26	35.2	28.35	0.0	7.6	33.2	0.06	0.58	0.0	0.0
	31	78. 6. 4	12.03	840.2	0.26	35.2	28.39	0.0	7.6	33.3	0.06	0.58	0.0	0.0
	32	78. 6. 4	12.28	861.5	0.26	35.0	28.62	0.0	7.8	33.3	0.05	0.58	0.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

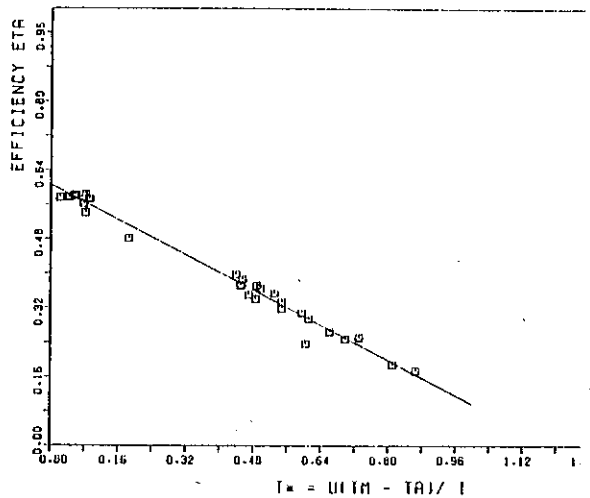
ETA=0.603   0.506*TSTAR

ETA=0.0   0.0 *TSTAR   0.0 (TSTAR**2)

LEAST SQUARE FIT

ETA=0.606   -.509*TSTAR

ETA=0.607   -.516*TSTAR   0.009(TSTAR**2)



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : NBS/ASHRAE , SITE:SPAIN

REFERENCE AREA: 2.31 M**2, FLUID:WATER , SLOPE: 45 DEGREE. MADRID

E

SITE = E COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/DSE = 1/2) = 1 NUMBER OF DATA POINTS = 33

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
	1	78. 6.21	0.0	921.0	0.0	46.0	21.80	0.0	5.4	48.9	0.29	0.49	1.5	0.0
	2	78. 6.22	0.0	630.0	0.0	48.0	26.50	0.0	2.4	59.9	0.53	0.34	1.5	0.0
	3	78. 6.28	0.0	1003.0	0.0	48.8	24.10	0.0	4.3	63.7	0.39	0.38	1.5	0.0
	4	78. 6.28	0.0	1013.0	0.0	48.0	24.90	0.0	4.5	64.0	0.38	0.39	2.5	0.0
	5	78. 7. 3	0.0	905.0	0.0	39.5	25.90	0.0	4.9	66.9	0.45	0.39	1.5	0.0
	6	78. 7. 3	0.0	943.0	0.0	45.8	30.30	0.0	4.7	72.2	0.44	0.42	1.5	0.0
	7	78. 7. 4	0.0	961.0	0.0	46.5	26.10	0.0	5.8	42.9	0.18	0.51	1.5	0.0
	8	78. 7. 4	0.0	988.0	0.0	46.4	27.30	0.0	5.7	46.6	0.19	0.49	1.5	0.0
	9	78. 7. 5	0.0	847.0	0.0	48.3	18.00	0.0	4.7	27.4	0.11	0.49	1.5	0.0
	10	78. 7. 7	0.0	845.0	0.0	47.6	20.80	0.0	3.5	58.5	0.47	0.37	1.5	0.0
	11	78. 7. 7	0.0	1015.0	0.0	47.6	24.80	0.0	4.6	68.2	0.43	0.40	1.5	0.0
	12	78. 7.10	0.0	767.0	0.0	47.6	31.60	0.0	4.0	54.1	0.29	0.46	1.5	0.0
	13	78. 7.10	0.0	907.0	0.0	46.9	31.20	0.0	5.3	52.6	0.24	0.50	1.5	0.0
	14	78. 7.11	0.0	914.0	0.0	47.4	25.50	0.0	5.7	28.3	0.03	0.57	1.5	0.0
	15	78. 7.11	0.0	961.0	0.0	47.8	26.40	0.0	5.9	29.1	0.03	0.54	1.5	0.0
	16	78. 7.11	0.0	995.0	0.0	47.8	28.00	0.0	6.0	30.1	0.02	0.53	1.5	0.0
	17	78. 7.12	0.0	970.0	0.0	25.2	27.20	0.0	11.0	32.9	0.06	0.52	1.5	0.0
	18	78. 7.12	0.0	981.0	0.0	25.6	28.20	0.0	11.1	34.3	0.06	0.53	1.5	0.0
	19	78. 7.14	0.0	832.0	0.0	25.0	30.70	0.0	6.5	76.2	0.55	0.36	1.5	0.0
	20	78. 7.14	0.0	895.0	0.0	24.8	32.30	0.0	8.0	74.8	0.47	0.41	1.5	0.0
	21	78. 7.14	0.0	947.0	0.0	25.0	34.00	0.0	8.3	73.9	0.42	0.40	1.5	0.0
	22	78. 7.14	0.0	842.0	0.0	25.0	36.50	0.0	7.3	71.8	0.42	0.40	1.5	0.0
	23	78. 7.17	[illegible]	923.0	0.0	24.4	34.90	0.0	10.7	48.0	0.14	0.52	1.5	0.0
	24	78. 7.17	0.0	967.0	0.0	25.0	37.00	0.0	10.7	52.0	0.15	0.51	1.5	0.0
	25	78. 7.18	0.0	[illegible]	0.0	47.6	29.80	0.0	3.7	63.4	0.40	0.39	1.5	0.0
	26	78. 7.19	0.0	1018.3	0.0	25.6	26.30	0.0	6.3	89.7	0.62	0.29	1.5	0.0
	27	78. 7.20	0.0	943.0	0.0	25.0	27.00	0.0	6.2	90.3	0.67	0.30	1.5	0.0
	28	78. 7.20	0.0	1010.0	0.0	25.0	29.90	0.0	7.4	91.8	0.61	0.34	1.5	0.0
	29	78. 7.20	0.0	802.0	0.0	25.0	31.80	0.0	4.8	90.9	0.74	0.27	1.5	0.0
	30	78. 7.21	0.0	745.0	0.0	17.7	33.70	0.0	6.2	91.7	0.78	0.27	1.5	0.0
	31	78. 7.21	0.0	975.0	0.0	17.2	31.40	0.0	11.2	93.4	0.63	0.36	1.5	0.0
	32	78. 7.21	0.0	970.0	0.0	17.4	30.10	0.0	10.5	92.2	0.64	0.35	1.5	0.0
	33	78. 7.24	0.0	866.0	0.0	25.0	30.40	0.0	6.6	85.4	0.63	0.35	1.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

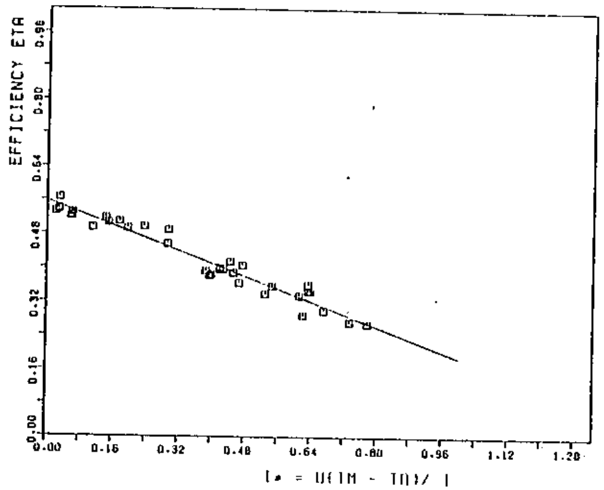
ETA=0.0 0.0 *TSTAR

ETA=0.551 0.359*TSTAR 0.007(TSTAR**2)

LEAST SQUARE FIT

ETA=0.558 -.368*TSTAR

ETA=0.555 -.330*TSTAR -.024(TSTAR**2)



COLLE.TOR TYPE: E#-2 , TESTING PROCEDURE : NBS/ASHRAE , SITE: GREAT B.
REFERENCE AREA: . I M**2, FLUID:WATER , SLOPE: 45.0. CARDIFF

GB

SITE - GB   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 5

ID	NO	DATE	HOUR		IO/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	77. 7. 4	13.30	841.0	0.29	25.5	26.20	0.0	0.0	44.4	0.22	0.48	1.0	0.0
1	2	77. 7. 6	15.13	740.0	0.30	25.5	26.80	0.0	0.0	54.5	0.37	0.41	1.5	0.0
1	3	77. 8. 1	15.05	829.0	0.0	25.5	23.50	0.0	0.0	71.3	0.58	0.34	2.0	0.0
1	4	77. 8.10	15.25	707.0	0.28	25.5	25.00	0.0	0.0	88.4	0.90	0.22	1.5	0.0
1	5	77. 8.10	16.40	492.0	0.32	25.5	24.70	0.0	0.0	80.1	1.13	0.14	1.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.550   0.370*TSTAR

ETA=0.0   0.0 *TSTAR   0.0 (TSTAR**2)

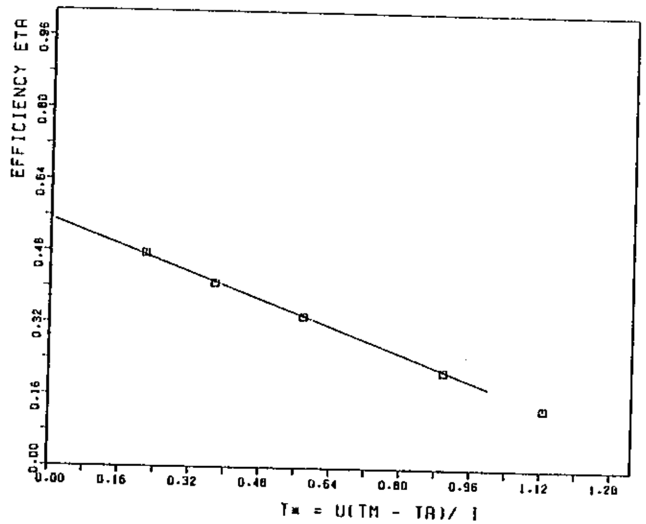
LEAST SQUARE FIT

ETA=0.553   -.373*TSTAR

ETA=0.562   -.408*TSTAR   0.026(TSTAR**2)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE ; SITE: GREAT B.
REFERENCE AREA: 2.31 M**2; FLUID:WATER ; SLOPE: 45.0. CARDIFF

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE· IEA-2 , TESTING PROCEDURE : NBS/ASHRAE ;SITE:JAPAN

REPRESENTATIVE VALUES ONLY, FLUID:H2O ;SLOPE:37.93 DEGREE. NAGOYA

J

SITE = J COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1 NUMBER OF DATA POINTS = 5

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	78. 4.14	13.37	800.7	0.28	43.5	18.66	0.0	5.3	27.4	0.11	0.53	1.7	0.0
1	2	78. 4.15	10.52	830.0	0.32	42.6	19.35	0.0	5.0	42.3	0.28	0.47	0.9	0.0
1	3	78. 4.19	11.37	964.5	0.14	42.8	18.00	0.0	5.1	59.4	0.43	0.41	2.1	0.0
1	4	78. 4.22	10.52	952.4	0.14	45.1	16.76	0.0	3.6	76.1	0.62	0.31	2.2	0.0
1	5	78. 5. 2	13.22	892.4	0.22	45.8	20.94	0.0	2.2	92.9	0.81	0.21	5.7	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.0 0.0 *TSTAR

ETA=0.564 0.301*TSTAR 0.178(TSTAR**2)

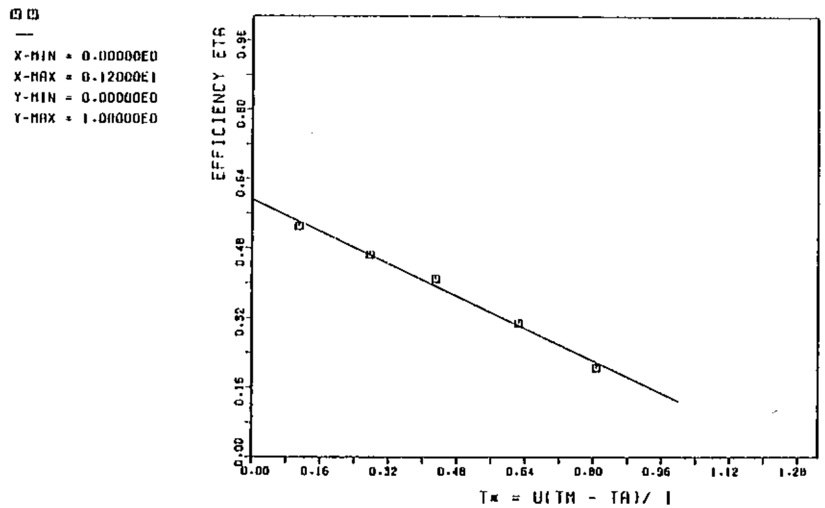
LEAST SQUARE FIT

ETA=0.592 -.464*TSTAR

ETA=0.561 -.275*TSTAR -.206(TSTAR**2)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE ;SITE:JAPAN

REPRESENTATIVE VALUES ONLY: FLUID:H2O ;SLOPE:37.93 DEGREE. NAGOYA



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : NBS/ASHRAE, SITE:NETHERL.
REFERENCE AREA: 2.315 M**2, FLUID:WATER , SLOPE: 45 DEGREE. DELFT

NL

SITE = NL   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 8

ID	NO	DATE	HOUR		ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
	1	177. 5.25	13.00	969.0	0.13	28.6	19.70	0.0	10.6	20.7	0.01	0.57	8.5	0.0
	2	177. 5.25	14.00	955.0	0.13	28.7	19.80	0.0	10.2	22.6	0.03	0.56	8.5	0.0
	3	177. 5.25	14.30	944.0	0.13	28.7	20.70	0.0	9.8	24.9	0.05	0.54	8.5	0.0
	4	177. 5.25	15.15	935.0	0.13	28.6	20.90	0.0	9.4	29.8	0.10	0.53	8.5	0.0
	5	177. 5.25	15.45	933.0	0.13	28.6	20.90	0.0	8.8	37.5	0.18	0.49	8.5	0.0
	6	177. 5.25	16.30	905.0	0.14	28.8	20.90	0.0	7.8	46.2	0.28	0.45	8.5	0.0
	7	177. 5.25	17.00	844.0	0.15	28.7	21.30	0.0	6.7	52.9	0.37	0.41	8.5	0.0
	8	177. 5.25	17.30	771.0	0.0	28.5	20.80	0.0	4.9	66.7	0.60	0.33	5.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.0   0.0 *TSTAR

ETA=0.0   0.0 *TSTAR   0.0 (TSTAR**2)

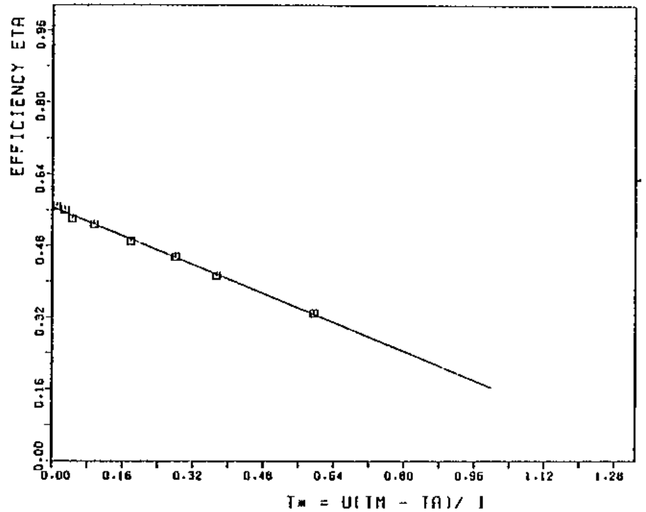
LEAST SQUARE FIT

ETA=0.567   -.405*TSTAR

ETA=0.569   -.438*TSTAR   0.059(TSTAR**2)

COLLECTOR TYPE: IEA-2 : TESTING PROCEDURE : NBS/ASHRAE: SITE:NETHERL.
REFERENCE AREA: 2.315 M**2: FLUID:WATER : SLOPE: 45 DEGREE. DELFT

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE; SITE:SWEDEN
REFERENCE AREA: 2.320 M**2; FLUID:WATER ; SLOPE: 45 DEGREE. BORAS

S

SITE = S   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 17

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	77. 9.19	13.00	931.0	0.06	43.0	20.00	0.0	5.7	33.2	0.14	0.48	1.6	0.0
1	2	77. 9.19	13.15	921.0	0.06	43.0	20.20	0.0	5.9	33.5	0.14	0.50	1.4	0.0
1	3	77. 9.19	13.30	904.0	0.06	43.0	20.00	0.0	5.9	33.3	0.15	0.52	1.7	0.0
1	4	77. 9.19	13.45	886.0	0.06	43.0	20.60	0.0	5.9	33.2	0.14	0.52	1.1	0.0
1	5	77. 9.19	14.20	866.0	0.06	43.0	20.50	0.0	5.1	43.3	0.26	0.46	1.4	0.0
1	6	77. 9.19	14.35	845.0	0.06	44.0	20.50	0.0	5.0	43.3	0.27	0.47	1.3	0.0
1	7	77. 9.19	14.50	815.0	0.06	44.0	20.50	0.0	4.8	43.2	0.28	0.47	1.7	0.0
1	8	77. 9.19	15.05	783.0	0.07	44.0	20.90	0.0	4.6	43.0	0.28	0.46	1.2	0.0
1	9	77. 9.20	10.00	842.0	0.08	44.0	13.50	0.0	3.7	53.1	0.47	0.35	2.0	0.0
1	10	77. 9.20	10.35	846.0	0.09	44.0	15.30	0.0	3.9	53.3	0.45	0.37	1.6	0.0
1	11	77. 9.20	10.50	848.0	0.09	44.0	15.90	0.0	3.9	53.2	0.44	0.37	1.9	0.0
1	12	77. 9.20	11.05	840.0	0.09	44.0	16.00	0.0	3.9	53.2	0.44	0.37	1.8	0.0
1	13	77. 9.20	11.50	866.0	0.09	43.0	16.50	0.0	3.6	62.6	0.53	0.32	2.0	0.0
1	14	77. 9.20	12.05	874.0	0.09	43.0	17.10	0.0	3.7	62.7	0.52	0.33	1.9	0.0
1	15	77. 9.20	12.20	885.0	0.09	43.0	17.20	0.0	3.8	62.8	0.51	0.33	1.9	0.0
1	16	77. 9.20	12.35	886.0	0.09	43.0	17.30	0.0	3.8	62.8	0.51	0.33	1.8	0.0
	17	77. 9.20	12.50	893.0	0.08	44.0	17.60	0.0	3.8	62.8	0.51	0.34	2.1	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.574 0.471*TSTAR

ETA=0.551 0.281*TSTAR 0.022(TSTAR**2)

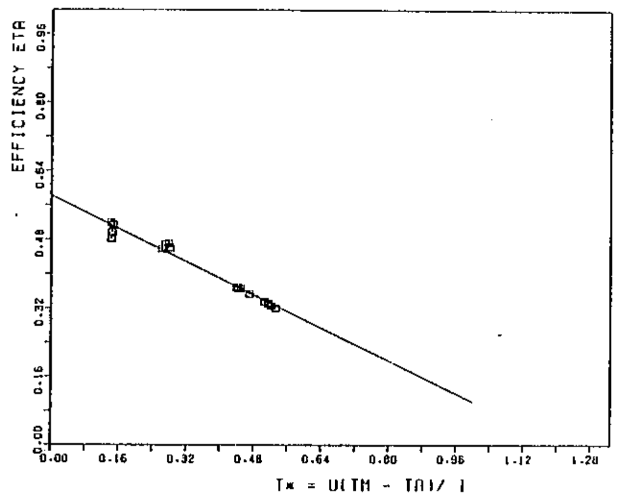
LEAST SQUARE FIT

ETA=0.582 -.480*TSTAR

ETA=0.531 -.102*TSTAR -.563(TSTAR**2)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : NBS/ASHRAE; SITE:SWEDEN
REFERENCE AREA: 2.320 M**2; FLUID:WATER ; SLOPE: 45 DEGREE. BORAS

X-MIN = 0.00000E0
X-MAX = 0.12000E1
Y-MIN = 0.00000E0
Y-MAX = 1.00000E0



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : NBS/ASHRAE , SITE:USA

REFERENCE AREA: 2.29 M**2, FLUID:DEMIN.H2O , SLOPE: 25/27 DEGREE

USA

SITE = USA   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS = 29

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	78. 4.28	11.42	1045.0	0.11	45.4	18.40	0.0	5.9	42.6	0.23	0.47	1.3	0.0
1	2	78. 4.28	11.47	1045.0	0.11	45.4	18.50	0.0	5.8	42.7	0.23	0.46	3.9	0.0
1	3	78. 4.28	11.52	1051.0	0.11	45.4	18.30	0.0	6.1	42.7	0.23	0.48	2.6	0.0
1	4	78. 4.28	11.57	1053.0	0.11	45.4	18.50	0.0	6.0	42.6	0.23	0.47	5.3	0.0
1	5	78. 4.28	12.03	1051.0	0.11	45.4	18.60	0.0	5.9	42.7	0.23	0.47	2.8	0.0
1	6	78. 4.28	12.08	1038.0	0.11	45.4	18.60	0.0	6.0	42.7	0.23	0.48	3.7	0.0
1	7	78. 4.28	12.13	1043.0	0.11	45.4	18.20	0.0	6.1	42.7	0.23	0.48	2.0	0.0
2	1	78. 5. 1	12.55	1020.0	0.12	44.8	10.90	0.0	4.5	61.6	0.49	0.36	4.3	0.0
2	2	78. 5. 1	13.00	1020.0	0.12	44.8	11.10	0.0	4.4	61.7	0.49	0.35	3.0	0.0
2	3	78. 5. 1	13.05	1003.0	0.12	44.8	12.00	0.0	4.4	61.7	0.49	0.35	1.1	0.0
2	4	78. 5. 1	13.09	1002.0	0.12	44.8	11.80	0.0	4.3	61.8	0.50	0.35	2.8	0.0
2	5	78. 5. 1	13.15	1050.0	0.12	44.5	11.80	0.0	3.8	74.8	0.60	0.29	0.0	0.0
2	6	78. 5. 1	13.20	1053.0	0.12	44.5	11.60	0.0	3.8	74.7	0.60	0.30	3.2	0.0
2	7	78. 5. 2	12.04	1032.0	0.11	44.3	13.20	0.0	3.3	84.0	0.68	0.26	3.2	0.0
2	8	78. 5. 2	12.09	1032.0	0.11	44.3	13.90	0.0	3.3	84.1	0.68	0.26	5.0	0.0
2	9	78. 5. 2	12.14	1031.0	0.11	44.3	13.80	0.0	3.3	84.1	0.68	0.26	3.8	0.0
2	10	78. 5. 2	12.19	1017.0	0.11	44.3	14.00	0.0	3.3	84.2	0.68	0.26	0.1	0.0
2	11	78. 5. 2	12.23	1020.0	0.11	44.3	13.80	0.0	3.3	84.3	0.69	0.26	3.0	0.0
2	12	78. 5. 3	12.16	1025.0	0.13	45.3	15.80	0.0	6.6	27.5	0.11	0.53	1.1	0.0
2	13	78. 5. 3	12.21	1016.0	0.13	45.3	15.80	0.0	6.5	27.6	0.12	0.53	2.5	0.0
2	14	78. 5. 3	12.25	1025.0	0.13	45.3	16.00	0.0	6.5	27.7	0.11	0.53	1.8	0.0
2	15	78. 5. [illegible]	11.55	1041.0	0.13	45.3	15.10	0.0	6.7	26.9	0.11	0.53	2.8	0.0
2	16	78. 5. 3	.00	1041.0	0.13	45.3	15.40	0.0	6.7	27.0	0.11	0.53	1.0	0.0
2	17	78. 5. 3	12.05	10[illegible]3.0	0.13	45.3	15.80	0.0	6.7	27.1	0.11	0.53	0.5	0.0
2	18	78. 5. 3	12.10	1023.0	0.13	45.3	16.50	0.0	6.6	27.3	0.11	0.53	2.5	0.0
2	19	78. 5. 1	10.55	1017.0	0.13	44.8	11.00	0.0	4.2	61.4	0.49	0.34	3.0	0.0
2	20	78. 5. 1	11.00	1028.0	0.13	44.8	11.60	0.0	4.3	61.5	0.49	0.34	1.6	0.0
2	21	78. 5. 1	11.05	1038.0	0.13	44.8	9.60	0.0	4.3	61.6	0.50	0.34	3.3	0.0
2	22	78. 5. 1	11.03	1030.0	0.13	44.8	10.70	0.0	4.3	61.7	0.49	0.34	2.7	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

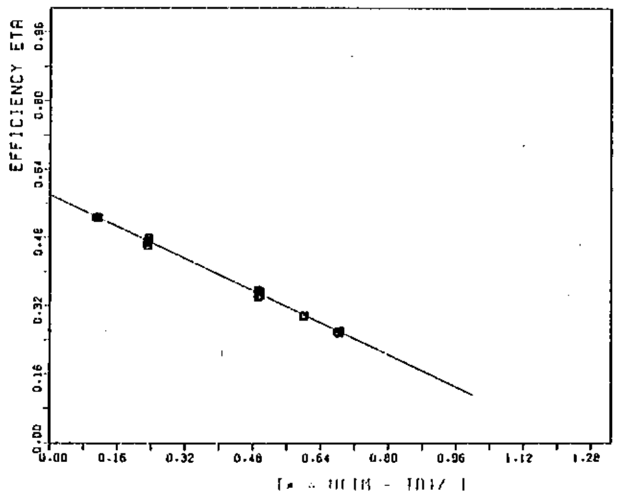
ETA=0.583 0.471*TSTAR

ETA=0.0 0.0 *TSTAR 0.0 (TSTAR**2)

LEAST SQUARE FIT

ETA=0.581 -.470*TSTAR

ETA=0.581 -.474*TSTAR 0.005(TSTAR**2)



APPENDIX E

Data: IEA-1 Collector
BSE Procedure
EIR Procedure

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE: EIR. SITE:SWITZERLAND

REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE: 40 DEGREE

CH

SITE = CH   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/DSE = 1/2) = 0   NUMBER OF DATA POINTS = 21

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	78. 7.30	11.30	862.5	0.22	14.8	31.80	0.0	19.3	37.2	0.06	0.82	1.9	0.0
1	2	78. 7.30	11.36	867.8	0.22	14.8	31.90	0.0	19.4	37.4	0.06	0.82	2.1	0.0
1	3	78. 7.30	11.42	876.8	0.22	14.8	32.10	0.0	19.7	37.6	0.06	0.82	2.1	0.0
1	4	78. 7.30	11.48	871.4	0.22	14.8	32.20	0.0	19.7	37.9	0.06	0.83	2.2	0.0
1	5	78. 7.30	11.54	876.7	0.22	14.8	32.20	0.0	19.7	38.1	0.07	0.82	2.0	0.0
1	6	78. 7.30	12.00	944.0	0.21	14.8	32.50	0.0	20.3	38.4	0.06	0.82	2.0	0.0
1	7	78. 7.30	12.06	914.8	0.20	14.8	32.10	0.0	20.4	38.8	0.07	0.82	2.6	0.0
1	8	78. 7.30	12.12	920.4	0.20	14.8	32.50	0.0	20.5	39.0	0.07	0.82	2.6	0.0
1	9	78. 7.30	12.18	919.2	0.20	14.9	32.70	0.0	20.7	39.2	0.07	0.83	2.4	0.0
1	10	78. 7.30	12.24	914.4	0.20	14.9	32.50	0.0	20.7	39.4	0.07	0.84	2.9	0.0
1	11	78. 7.30	12.30	925.0	0.20	14.8	32.10	0.0	20.7	39.6	0.08	0.82	2.4	0.0
1	12	78. 7.30	12.36	919.7	0.20	14.9	32.70	0.0	20.9	39.6	0.07	0.84	2.7	0.0
1	13	78. 7.30	12.42	915.9	0.20	14.9	32.80	0.0	20.7	39.7	0.07	0.83	2.8	0.0
1	14	78. 7.30	12.48	914.1	0.20	14.9	33.10	0.0	20.7	39.7	0.07	0.84	2.4	0.0
1	15	78. 7.30	12.54	920.9	0.20	14.9	32.50	0.0	20.7	39.9	0.08	0.83	3.3	0.0
1	16	78. 7.30	13.00	920.0	0.19	14.9	32.60	0.0	20.7	39.9	0.08	0.83	2.8	0.0
1	17	78. 7.30	13.06	922.9	0.19	14.9	33.10	0.0	20.9	40.0	0.07	0.84	2.2	0.0
1	18	78. 7.30	13.12	877.4	0.19	14.9	33.60	0.0	20.6	39.8	0.07	0.87	2.2	0.0
1	19	78. 7.30	13.18	894.7	0.19	14.9	33.40	0.0	20.2	39.7	0.07	0.83	2.9	0.0
1	20	78. 7.30	13.24	831.5	0.19	14.9	33.80	0.0	20.4	39.7	0.07	0.84	2.2	0.0
1	21	78. 7.30	13.30	864.3	0.19	14.9	34.30	0.0	20.2	39.6	0.06	0.86	2.3	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FITO   FOR DETAILS SEE APPENDIX A

ETA=0.0   0.0 *TSTAR

ETA=0.854   0.0 *TSTAR   0.0 (TSTAR**2)

THE AVERAGED ETA

ETAO= 0.8535

LEAST SQUARE FIT

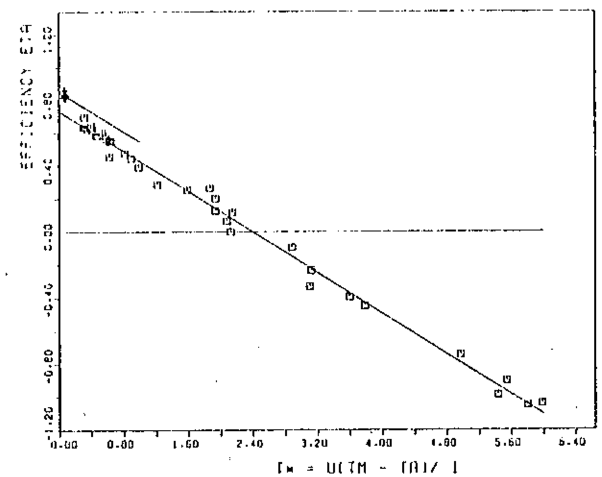
ETA=0.843   -.161*TSTAR

ETA=0.636   5.715*TSTAR   *****(TSTAR**2)

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE: EIR. SITE:SWITZERLAND

REFERENCE AREA: 1.79 M**2; FLUID: WATER ;SLOPE:40.DIFFUSE-LIGHT

X-MIN = 0.000000E0
X-MAX = 0.600000E1
Y-MIN = -0.110975E1
Y-MAX = 1.000000E0



COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE: EIR. SITE:SWITZERLAND

REFERENCE AREA: 1.79 M**2; FLUID: WATER ;SLOPE:40.DIFFUSE-LIGHT

CH

SITE = CH   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS - 38

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	78. 8.14	5.48	11.6	0.88	14.4	12.50	0.0	-0.3	19.2	5.80	****	0.6	0.0
1	2	78. 8.14	5.54	12.4	0.88	14.5	12.50	0.0	-0.3	19.2	5.43	-.99	0.5	0.0
1	2	78. 8.14	5.54	12.4	0.88	14.5	12.50	0.0	-0.3	19.2	5.43	-.99	0.5	0.0
1	4	78. 8.14	6.06	11.1	0.87	14.5	12.60	0.0	-0.3	19.2	5.98	****	0.5	0.0
1	5	78. 8.14	6.12	12.0	0.88	14.5	12.60	0.0	-0.3	19.3	5.54	-.90	0.5	0.0
1	6	78. 8.14	6.18	13.6	0.93	14.5	12.50	0.0	-0.3	19.3	4.97	-.74	1.2	0.0
1	7	78. 8.14	6.24	17.7	0.89	14.4	12.50	0.0	-0.2	19.2	3.78	-.45	0.7	0.0
1	8	78. 8.14	6.30	18.4	0.90	14.4	12.60	0.0	-0.2	19.2	3.59	-.39	0.7	0.0
1	9	78. 8.14	6.36	21.6	0.91	14.5	12.60	0.0	-0.2	19.3	3.10	-.33	0.8	0.0
1	10	78. 8.14	6.42	21.6	0.92	14.5	12.60	0.0	-0.1	19.3	3.12	-.23	0.9	0.0
1	11	78. 8.14	6.48	29.6	0.92	14.5	12.60	0.0	-0.1	19.4	2.88	-.10	0.9	0.0
1	12	78. 8.14	6.54	32.1	0.91	14.4	12.60	0.0	0.0	19.4	2.12	0.0	1.0	0.0
1	13	78. 8.14	7.00	32.5	0.93	14.4	12.70	0.0	0.1	19.4	2.07	0.06	1.0	0.0
1	14	78. 8.14	7.06	31.5	0.92	14.5	12.70	0.0	0.1	19.5	2.14	0.12	1.0	0.0
1	15	78. 8.14	7.12	34.5	0.92	14.4	12.80	0.0	0.1	19.5	1.93	0.13	0.6	0.0
1	16	78. 8.14	7.18	34.7	0.91	14.4	12.90	0.0	0.2	19.6	1.93	0.20	0.5	0.0
1	17	78. 8.14	7.24	35.6	0.92	14.4	13.00	0.0	0.3	19.6	1.86	0.27	0.4	0.0
1	18	78. 8.14	7.30	41.6	0.93	14.4	13.10	0.0	0.3	19.7	1.58	0.25	0.4	0.0
1	19	78. 8.14	7.36	54.5	0.96	14.4	13.10	0.0	0.4	19.7	1.21	0.29	0.5	0.0
1	20	78. 8.14	7.42	69.4	0.94	14.4	13.10	0.0	0.8	19.9	0.98	0.39	0.6	0.0
1	21	78. 8.14	7.48	76.0	0.92	14.4	13.20	0.0	0.9	20.0	0.89	0.45	1.0	0.0
1	22	78. 8.14	7.54	83.1	0.94	14.4	13.30	0.0	1.1	20.1	0.81	0.48	0.6	0.0
1	23	78. 8.14	8.00	110.9	0.94	13.8	13.20	0.0	1.5	20.2	0.62	0.46	1.1	0.0
1	24	78. 8.14	8.06	109.6	0.93	14.0	13.30	0.0	1.7	20.3	0.64	0.55	0.9	0.0
1	25	78. 8.14	8.12	112.4	0.94	14.0	13.30	0.0	1.8	20.3	0.62	0.55	1.3	0.0
1	26	78. 8.14	8.18	122.9	0.93	14.1	13.20	0.0	2.0	20.4	0.59	0.56	1.2	0.0
1	27	78. 8.14	8.24	123.7	0.93	14.2	13.40	0.0	2.1	20.4	0.57	0.58	1.2	0.0
1	28	78. 8.14	8.30	128.7	0.93	14.1	13.70	0.0	2.2	20.6	0.54	0.58	0.8	0.0
1	29	78. 8.14	8.36	129.9	0.90	14.1	13.90	0.0	2.3	20.8	0.53	0.60	0.9	0.0
1	30	78. 8.14	8.42	144.0	0.94	14.1	14.10	0.0	2.4	20.9	0.47	0.58	1.0	0.0
1	31	78. 8.14	8.48	154.9	0.94	14.1	14.20	0.0	2.6	21.1	0.45	0.59	1.3	0.0
1	32	78. 8.14	8.54	165.4	0.93	14.1	14.40	0.0	2.9	21.3	0.41	0.61	0.8	0.0
1	33	78. 8.14	9.00	168.7	0.93	14.1	14.90	0.0	3.1	21.4	0.39	0.64	0.6	0.0
1	34	78. 8.14	9.06	166.6	0.92	14.0	14.80	0.0	3.1	21.5	0.40	0.65	0.8	0.0
1	35	78. 8.14	9.12	183.6	0.92	14.0	15.20	0.0	3.3	21.6	0.35	0.63	0.5	0.0
1	36	78. 8.14	9.18	194.5	0.92	14.0	15.40	0.0	3.6	21.7	0.32	0.64	0.7	0.0
1	37	78. 8.14	9.24	213.1	0.92	14.0	15.60	0.0	3.9	22.0	0.30	0.64	0.7	0.0
1	38	78. 8.14	9.30	205.9	0.92	14.0	15.70	0.0	4.2	22.1	0.31	0.70	0.6	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT   FOR DETAILS SEE APPENDIX A

ETA=0.0   0.0 *ISTAR

ETA=0.730   -.304*ISTAR   0.0 (ISTAR**2)

LEAST SQUARE FIT

ETA=0.774   -.307*ISTAR

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : ASE/INDOOR: SITE:GERMANY

REFERENCE AREA: 1.79 M**2: FLUID: WATER ; SLOPE: 45 DEGREE: JUELICH

D

SITE = D COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 6

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.810- -0.34600*TSTAR--0.30000E-02(TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM	WIND	TSKY	C-P
4	1	178. 5.25	11.00	35.90	18.70	50.6	1.60	49.8	31.1	240.2	7.72	5.0	0.0	4186.7
4	2	178. 5.25	13.05	37.20	18.90	68.7	2.80	67.3	48.4	436.3	9.01	5.0	0.0	4186.7
4	3	178. 5.25	15.00	36.90	18.90	90.8	4.40	88.6	69.6	683.2	9.82	5.0	0.0	4186.7
4	4	178. 5.25	15.25	36.90	18.90	90.8	4.40	88.6	69.6	683.2	9.82	5.0	0.0	4186.7
4	5	178. 5.25	16.45	37.10	18.90	70.4	2.90	67.4	48.5	450.7	9.29	5.0	0.0	4186.7
4	6	178. 5.26	9.15	37.00	18.80	50.0	1.50	49.2	30.4	232.1	7.63	5.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.810- 0.34589*TSTAR- 0.30315E-03(TSTAR**2)*I

THE CORRECTED ETAO

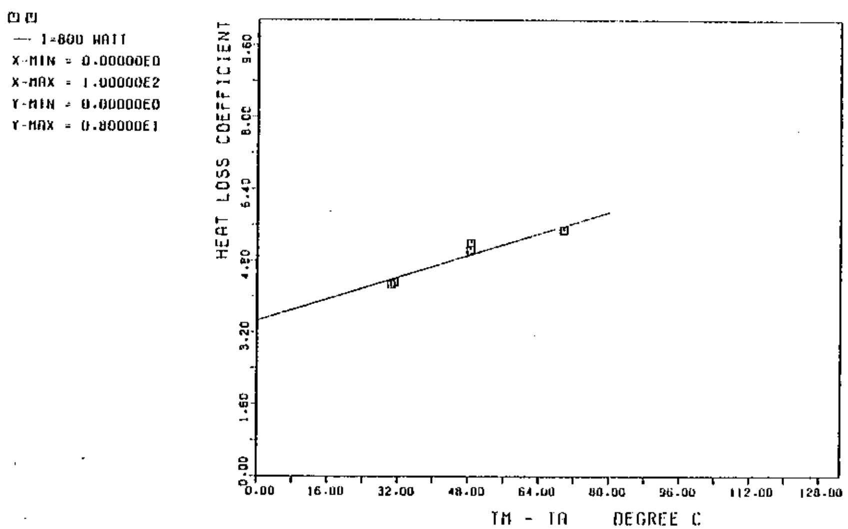
ETAO= 0.8060

LEAST SQUARE FIT

ETA=0.806- 0.34589*TSTAR- 0.30315E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/INDOOR: SITE:GERMANY

REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE: 45 DEGREE; JUELICH



COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : ASE/OUTDOOR,SITE: GERMANY
REFERENCE AREA: 1.79 M**2, FLUID: WATER , SLOPE: 45 DEGREE.JUELICH

D

SITE = D COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 4

IO	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
2	1	178. 5.30	11.30	928.0	0.0	35.6	24.40	22.1	9.0	26.6	0.02	0.81	4.5	0.0
2	2	178. 5.30	12.10	925.0	0.24	35.6	25.90	22.4	9.0	26.9	0.01	0.81	4.5	0.0
2	3	178. 5.30	12.40	917.0	0.0	35.4	26.30	22.4	8.8	27.0	0.01	0.80	4.5	0.0
2	4	178. 5.30	13.15	887.0	0.0	35.4	26.40	22.5	8.5	26.7	0.00	0.79	4.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

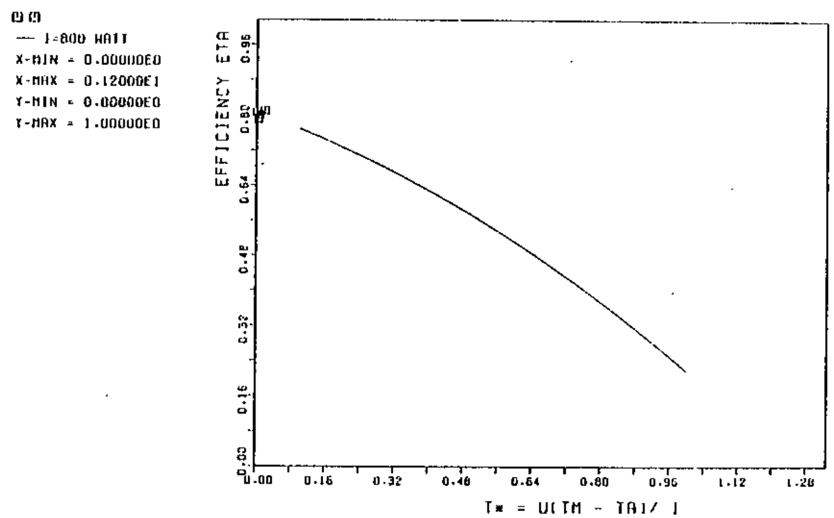
ETA=0.810 0.0 *TSTAR

ETA=0.0 0.0 *TSTAR 0.0 (TSTAR**2)

THE AVERAGED ETA

ETAO= 0.8025

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/INDOOR; SITE:GERMANY
REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE: 45 DEGREE; JUELICH



COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : BSE/INDOOR ;SITE:GERMANY

REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE:45 DEGREE.HEIDELBERG

D

SITE = D COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 6

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.858- 0.42800*TSTAR- 0.23000E-03(TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	7.10	25.40	0.0	1.70	50.2	24.8	214.0	8.63	5.0	0.0	4186.7
1	2	0. 0. 0	0.0	7.40	26.70	0.0	3.30	70.0	43.3	411.0	9.49	5.0	0.0	4186.7
1	3	0. 0. 0	0.0	7.70	28.40	0.0	5.10	90.1	61.7	611.0	9.90	5.0	0.0	4186.7
1	4	0. 0. 0	0.0	7.30	27.90	0.0	5.30	90.0	62.1	633.0	10.19	5.0	0.0	4186.7
1	5	0. 0. 0	0.0	7.40	26.70	0.0	3.20	70.1	43.4	402.0	9.26	5.0	0.0	4186.7
1	6	0. 0. 0	0.0	7.30	26.20	0.0	1.70	50.1	23.9	204.0	8.54	5.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.858- 0.42720*TSTAR- 0.21841E-03(TSTAR**2)*I

THE CORRECTED ETAO

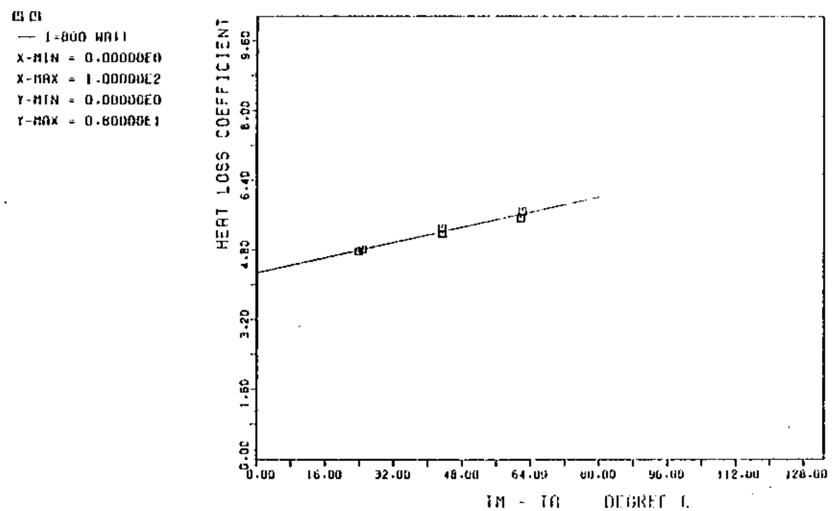
ETAO= 0.8583

LEAST SQUARE FIT

ETA=0.858- 0.42720*TSTAR- 0.21841E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:GERMANY

REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE:45 DEGREE.HEIDELBERG



COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/OUTDOOR ;SITE:GERMANY

REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE:VARIABLE .HEIDELBERG

D

SITE = 0   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2   NUMBER OF DATA POINTS = 4

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	0. 0. 0	0.0	864.0	0.0	43.8	25.30	0.0	7.4	32.2	0.08	0.87	5.0	0.0
1	2	0. 0. 0	0.0	717.0	0.0	38.9	25.10	0.0	6.3	31.9	0.09	0.79	5.0	0.0
1	3	0. 0. 0	0.0	903.0	0.0	36.4	26.00	0.0	8.5	37.2	0.12	0.80	5.0	0.0
1	4	0. 0. 0	0.0	910.0	0.0	32.0	25.80	0.0	9.5	39.8	0.15	0.78	5.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

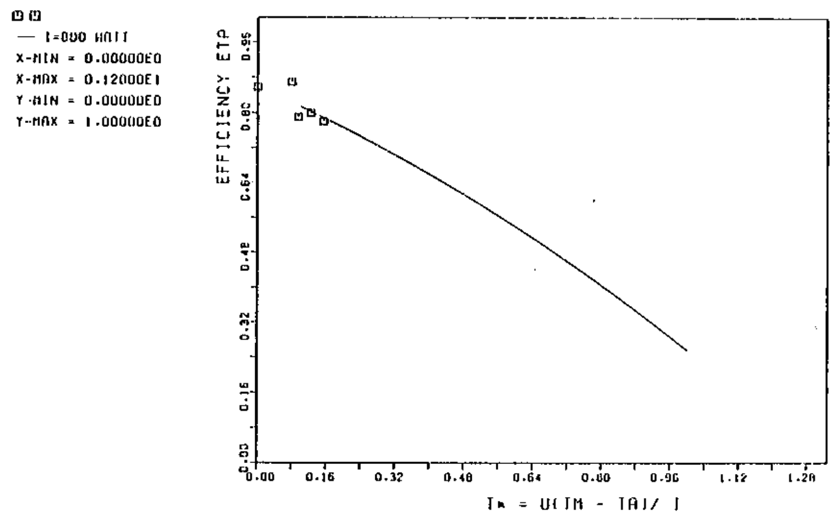
ETA=0.858 0.0 *TSTAR

ETA=0.858 0.428*TSTAR 0.000(TSTAR**2)

THE AVERAGED ETA

ETAO= 0.8100

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:GERMANY
REFERENCE AREA: 1.79 M**2; FLUID: WATER ; SLOPE:45 DEGREE.HEIDELBERG



COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : BSE/INDOOR ,SITE:DENMARK
REFERENCE AREA: 1.78 M**2, FLUID: WATER , SLOPE:45 DEGREE.COPENHAGEN **DK**

SITE = DK   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2   NUMBER OF DATA POINTS = 4

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.862- 0.35900*TSTAR- 0.23000E-03(TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	35.30	22.00	35.2	0.59	35.5	12.9	87.2	6.75	5.0	20.0	4186.7
1	2	0. 0. 0	0.0	35.20	21.10	54.5	1.78	55.4	32.5	262.3	7.99	5.0	20.0	4186.7
1	3	0. 0. 0	0.0	36.00	21.80	71.9	2.78	73.3	48.7	419.0	8.47	5.0	20.0	4186.7
1	4	0. 0. 0	0.0	36.20	21.60	87.2	3.79	89.1	63.7	574.4	8.85	5.0	20.0	4186.7

LEAST SQUARE FIT

ETA=0.862- 0.35975*TSTAR- 0.22941E-03(TSTAR**2)*I

THE CORRECTED ETAO

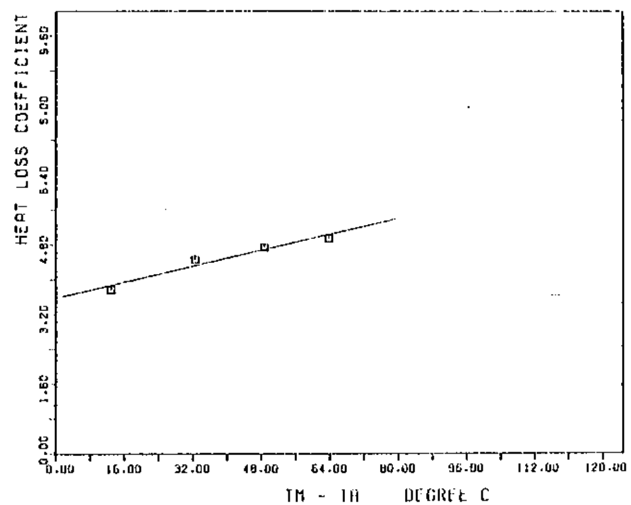
ETAO= 0.8570

LEAST SQUARE FIT

ETA=0.857- 0.35975*TSTAR- 0.22941E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:DENMARK
REFERENCE AREA: 1.78 M**2; FLUID: WATER ; SLOPE:45 DEGREE.COPENHAGEN

X-MIN = 0.00000E0
X-MAX = 1.00000E2
Y-MIN = 0.00000E0
Y-MAX = 0.80000E1



COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/OUTDOOR ;SITE:DENMARK

REFERENCE AREA: 1.78 M**2; FLUID: WATER ; SLOPE:45 DEGREE.COPENHAGEN

DK

SITE = DK   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2   NUMBER OF DATA POINTS = 12

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	177. 8. 2	11.15	961.0	0.22	33.7	21.40	0.0	10.4	19.8	0.04	0.85	6.0	0.0
1	2	177. 8. 2	11.30	951.0	0.23	33.3	21.70	0.0	10.3	19.9	0.04	0.84	6.0	0.0
1	3	177. 8. 2	11.45	944.0	0.23	33.0	21.60	0.0	10.3	19.8	0.04	0.84	6.0	0.0
1	4	177. 8. 2	12.00	976.0	0.22	32.7	22.00	0.0	10.6	19.9	0.03	0.83	6.0	0.0
1	5	177. 8. 2	12.15	984.0	0.23	32.7	22.30	0.0	10.9	19.9	0.03	0.84	6.0	0.0
1	6	177. 8. 2	12.30	980.0	0.24	32.3	22.20	0.0	10.8	19.9	0.03	0.83	6.0	0.0
1	7	177. 8. 5	11.15	898.0	0.33	35.2	21.30	0.0	9.2	22.9	0.07	0.84	6.0	0.0
1	8	177. 8. 5	11.30	907.0	0.33	35.2	21.60	0.0	9.3	22.9	0.07	0.84	6.0	0.0
1	9	177. 8. 5	11.45	898.0	0.35	35.2	21.50	0.0	9.2	22.9	0.07	0.84	6.0	0.0
1	10	177. 8. 5	12.00	916.0	0.36	35.2	21.50	0.0	9.2	22.9	0.07	0.82	6.0	0.0
1	11	177. 8. 5	12.15	918.0	0.37	35.2	21.60	0.0	9.4	22.9	0.06	0.84	6.0	0.0
1	12	177. 8. 5	12.30	886.0	0.40	35.7	21.70	0.0	9.1	22.9	0.06	0.85	6.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.862 0.0 *TSTAR

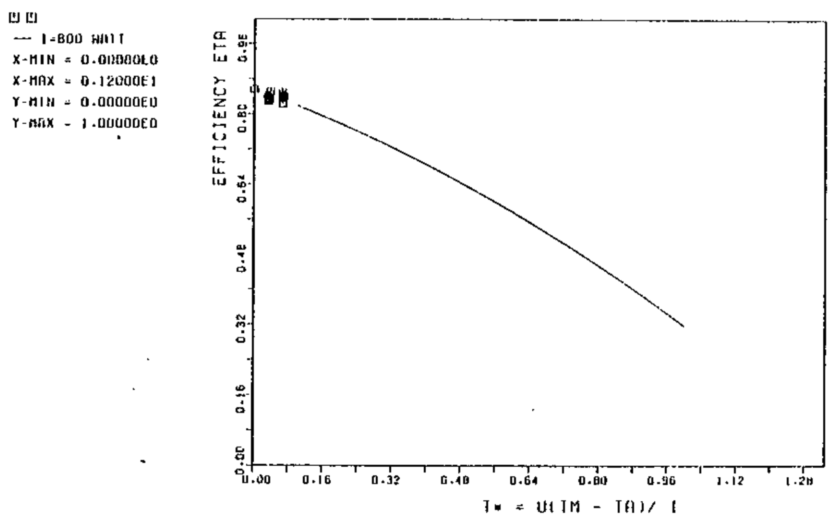
ETA=0.862 0.359*TSTAR 0.000(TSTAR**2)

THE AVERAGED ETA

ETA0= 0.8437

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:DENMARK

REFERENCE AREA: 1.78 M**2; FLUID: WATER ; SLOPE:45 DEGREE.COPENHAGEN



COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE +OUTDOOR/LOSS ,SITE:GREAT B.

REFERENCE AREA: 1.785 M**2, FLUID: WATER , SLOPE:45 DEGREE.CARDIFF

GB

SITE = GB COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 11

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.840- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

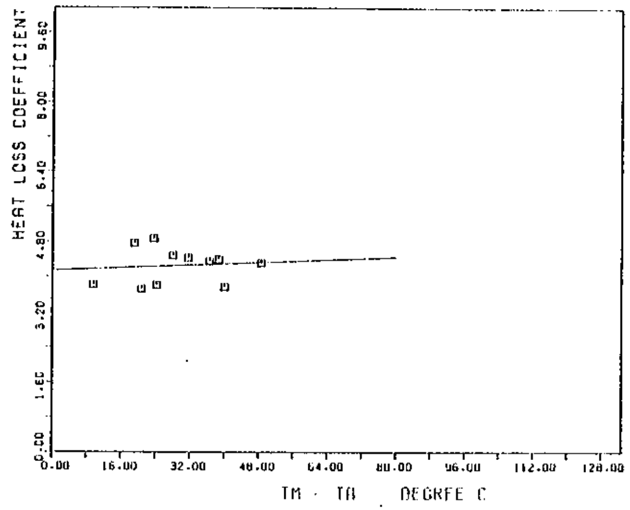
ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM	WIND	TSKY	C-P
	1	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	9.5	65.0	6.84	0.0	0.0	4186.7
	2	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	19.0	162.0	8.53	0.0	0.0	4186.7
	3	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	20.7	138.0	6.67	0.0	0.0	4186.7
	4	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	23.5	205.0	8.72	0.0	0.0	4186.7
	5	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	24.2	165.0	6.82	0.0	0.0	4186.7
	6	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	28.0	225.0	8.04	0.0	0.0	4186.7
	7	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	31.5	250.0	7.94	0.0	0.0	4186.7
	8	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	36.5	285.0	7.81	0.0	0.0	4186.7
	9	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	38.6	304.0	7.88	0.0	0.0	4186.7
	10	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	270.0	6.75	0.0	0.0	4186.7
	11	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	48.5	375.0	7.73	0.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.840- 0.41514*TSTAR- 0.38545E-04(TSTAR**2)*I

LEAST SQUARE FIT

ETA=0.840- 0.41514*TSTAR- 0.38545E-04(TSTAR**2)*I



COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : BSE/INDOOR ,SITE:NETHERL
REFERENCE AREA: 1.791 M**2, FLUID: WATER , SLOPE:45 DEGREE. DELFT

NL

SITE = NL   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2   NUMBER OF DATA POINTS = 3

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.780- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	34.40	25.70	0.0	0.55	37.3	11.6	79.7	6.88	5.0	20.0	4186.7
1	2	0. 0. 0	0.0	34.00	24.40	0.0	1.85	56.8	32.4	263.0	8.11	5.0	20.0	4186.7
1	3	0. 0. 0	0.0	34.80	24.00	0.0	3.14	77.5	53.5	459.0	8.58	5.0	20.0	4186.7

LEAST SQUARE FIT

ETA=0.780- 0.36513*TSTAR- 0.22629E-03(TSTAR**2)*I

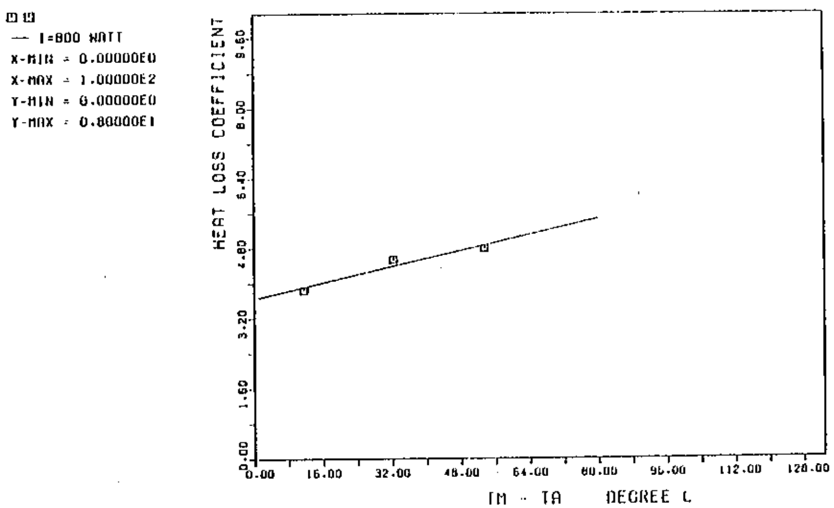
THE CORRECTED ETAO

ETAO= 0.7671

LEAST SQUARE FIT

ETA=0.767- 0.36513*TSTAR- 0.22629E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:NETHERL
REFERENCE AREA: 1.791 M**2; FLUID: WATER ; SLOPE:45 DEGREE. DELFT



COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE :OUTDOOR/LOSS ;SITE:JAPAN

REFERENCE AREA: 1.790 M**2; FLUID: WATER ; SLOPE:38 DEGREE.NAGOYA

J

SITE = J COLLECTOR TYPE IEA- 1 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 5

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.830- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	8.5	65.0	7.55	0.0	0.0	4186.7
1	2	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	20.2	155.0	7.67	0.0	0.0	4186.7
1	3	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	39.0	320.0	8.21	0.0	0.0	4186.7
1	4	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	57.0	490.0	8.60	0.0	0.0	4186.7
1	5	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	69.0	650.0	9.42	0.0	0.0	4186.7

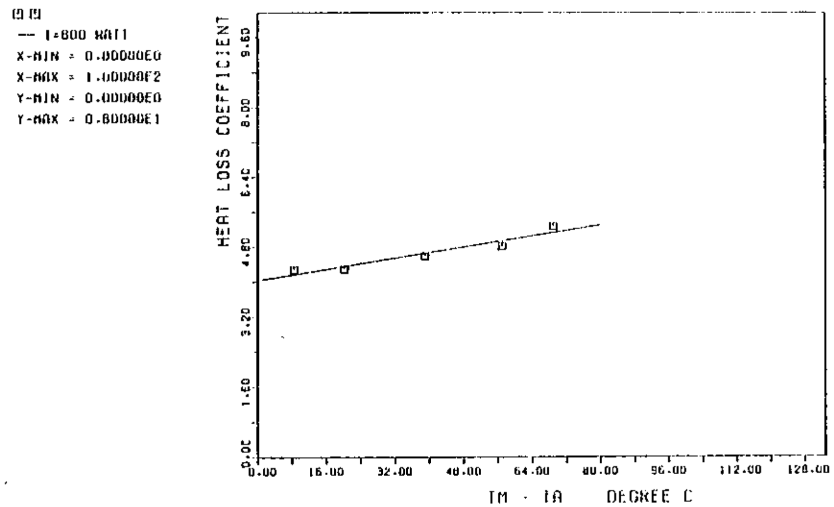
LEAST SQUARE FIT

ETA=0.830- 0.40317*TSTAR- 0.15742E-03(TSTAR**2)*I

LEAST SQUARE FIT

ETA=0.830- 0.40317*TSTAR- 0.15742E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-1 ; TESTING PROCEDURE :OUTDOOR/LOSS ;SITE:JAPAN
REFERENCE AREA: 1.790 M**2; FLUID: WATER ; SLOPE:38 DEGREE.NAGOYA



COLLECTOR TYPE: IEA-1 , TESTING PROCEDURE : BSE/INDOOR ,SITE:USA

REFERENCE AREA: 1.790 M**2, FLUID: WATER , SLOPE:45 DEGREE.NBS

USA

SITE = USA   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2   NUMBER OF DATA POINTS = 4

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.830- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	0.0	21.10	0.0	0.0	0.0	19.5	140.0	7.18	5.0	0.0	4186.7
1	2	0. 0. 0	0.0	0.0	21.10	0.0	0.0	0.0	34.5	277.0	8.03	5.0	0.0	4186.7
1	3	0. 0. 0	0.0	0.0	21.10	0.0	0.0	0.0	56.0	502.0	8.96	5.0	0.0	4186.7
1	4	0. 0. 0	0.0	0.0	21.10	0.0	0.0	0.0	66.5	645.0	9.70	5.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.830- 0.34547*TSTAR- 0.28918E-03(TSTAR**2)*I

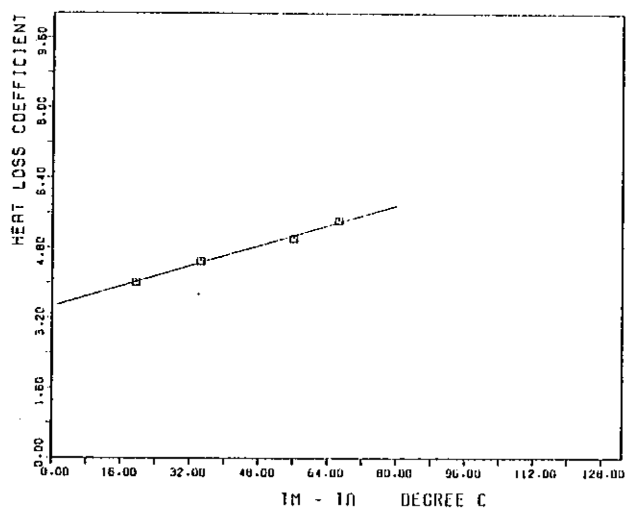
LEAST SQUARE FIT

ETA=0.830- 0.34547*TSTAR- 0.28918E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-1 : TESTING PROCEDURE : BSE/INDOOR :SITE:USA

REFERENCE AREA: 1.790 M**2; FLUID: WATER ; SLOPE:45 DEGREE.NBS

— I=800 WATT
X-MIN = 0.00000E0
X-MAX = 1.00000E2
Y-MIN = 0.00000E0
Y-MAX = 0.80000E1



APPENDIX F

Data: IEA-2 Collector
BSE Procedure
EIR Procedure

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : INDOOR/BSE.SITE:BELGIUM

REFERENCE AREA: 2.30 M**2; FLUID: WATER ; SLOPE: ? DEGREE.MONS

B

SITE = B   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2   NUMBER OF DATA POINTS = 7

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.609- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

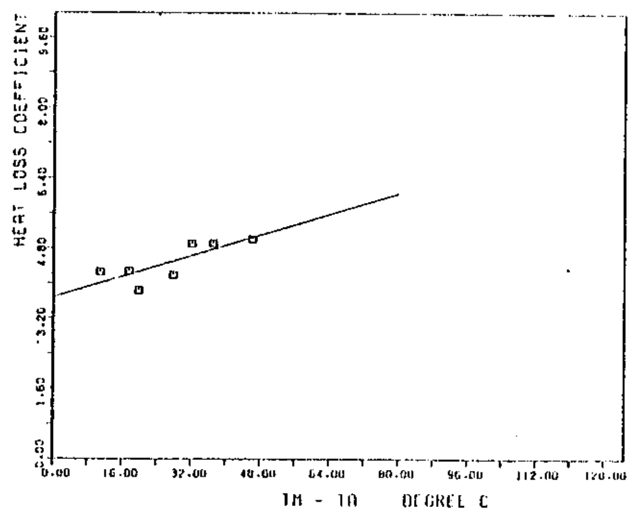
ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
	1	0. 0. 0	0.0	40.02	20.00	31.1	0.62	30.8	10.8	105.8	9.77	0.0	0.0	4186.7
	2	0. 0. 0	0.0	41.04	20.80	38.8	1.00	38.3	17.5	171.6	9.81	0.0	0.0	4186.7
	3	0. 0. 0	0.0	41.69	18.60	38.8	1.00	38.3	19.8	174.3	8.80	0.0	0.0	4186.7
	4	0. 0. 0	0.0	41.49	22.30	50.8	1.54	50.1	27.8	267.0	9.60	0.0	0.0	4186.7
	5	0. 0. 0	0.0	42.74	19.50	53.1	2.02	51.6	32.1	361.0	11.25	0.0	0.0	4186.7
	6	0. 0. 0	0.0	42.27	22.00	60.2	2.31	59.0	37.0	417.0	11.27	0.0	0.0	4186.7
	7	0. 0. 0	0.0	42.29	22.80	70.4	3.08	68.9	46.1	530.0	11.50	0.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.609- 0.36791*TSTAR- 0.29745E-03(TSTAR**2)*I

LEAST SQUARE FIT

ETA=0.609- 0.36791*TSTAR- 0.29745E-03(TSTAR**2)*I



REFERENCE AREA: 2.32 M**2; FLUID: WATER ; SLOPE: 40 DEGREE

CH

SITE = CH   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/21 - 0   NUMBER OF DATA POINTS = 21

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
	1	178. 7.30	11.30	862.5	0.22	14.8	31.80	0.0	16.4	35.7	0.05	0.54	1.9	0.0
	2	178. 7.30	11.36	867.8	0.22	14.8	31.90	0.0	16.6	36.0	0.05	0.54	2.1	0.0
	3	178. 7.30	11.42	876.8	0.22	14.8	32.10	0.0	16.8	36.2	0.05	0.54	2.1	0.0
	4	178. 7.30	11.48	871.4	0.22	14.8	32.20	0.0	16.7	36.4	0.05	0.54	2.2	0.0
	5	178. 7.30	11.54	876.7	0.22	14.8	32.20	0.0	16.8	36.6	0.05	0.54	2.0	0.0
	6	178. 7.30	12.00	944.0	0.21	14.8	32.50	0.0	17.2	36.9	0.05	0.54	2.0	0.0
	7	178. 7.30	12.06	914.8	0.20	14.8	32.10	0.0	17.3	37.3	0.06	0.54	2.6	0.0
	8	178. 7.30	12.12	920.4	0.20	14.8	32.50	0.0	17.3	37.4	0.05	0.53	2.6	0.0
	9	178. 7.30	12.18	919.2	0.20	14.9	32.70	0.0	17.4	37.5	0.05	0.54	2.4	0.0
	10	178. 7.30	12.24	914.4	0.20	14.9	32.50	0.0	17.4	37.7	0.06	0.54	2.9	0.0
	11	178. 7.30	12.30	925.0	0.20	14.8	32.10	0.0	17.5	38.0	0.06	0.54	2.4	0.0
	12	178. 7.30	12.36	919.7	0.20	14.9	32.70	0.0	17.5	38.0	0.06	0.54	2.7	0.0
	13	178. 7.30	12.42	915.9	0.20	14.9	32.80	0.0	17.4	38.0	0.06	0.54	2.8	0.0
	14	178. 7.30	12.48	914.1	0.20	14.9	33.10	0.0	17.4	38.1	0.05	0.54	2.4	0.0
	15	178. 7.30	12.54	920.9	0.20	14.9	32.50	0.0	17.3	38.3	0.06	0.54	3.3	0.0
	16	178. 7.30	13.00	920.0	0.19	14.9	32.60	0.0	17.4	38.2	0.06	0.54	2.8	0.0
	17	178. 7.30	13.06	922.9	0.19	14.9	33.10	0.0	17.5	38.2	0.05	0.54	2.2	0.0
	18	178. 7.30	13.12	877.4	0.19	14.9	33.60	0.0	17.0	38.0	0.05	0.55	2.2	0.0
	19	178. 7.30	13.18	894.7	0.19	14.9	33.40	0.0	17.0	38.1	0.05	0.54	2.9	0.0
	20	178. 7.30	13.24	891.5	0.19	14.9	33.80	0.0	17.0	38.0	0.05	0.54	2.2	0.0
	21	178. 7.30	13.30	864.3	0.19	14.9	34.30	0.0	16.9	37.9	0.04	0.56	2.3	0.0

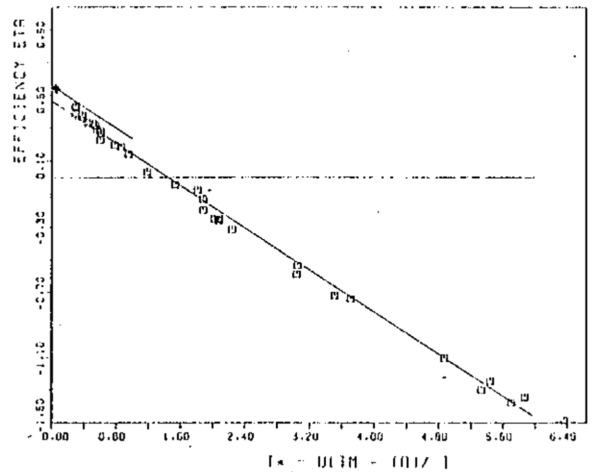
THE AUTHOR HAS GIVEN THE FOLLOWING DATA FITO   FOR DETAILS SEE APPENDIX A

ETA=0.0   0.0 *TSTAR

ETA-0.559   0.0 *TSTAR   0.0 (TSTAR**2)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE: EIR. SITE:SWITZERLAND
REFERENCE AREA: 2.32 M**2: FLUID: WATER :SLOPE:40.DIFFUSE-LIGHT

X-MIN = 0.000000E0
X-MAX = 0.636000E1
Y-MIN = -0.148510E1
Y-MAX = 1.000000E0



THE AVERAGED ETA

ETHD= 0.5570

LEAST SQUARE FIT

ETA+0.566   -.478*TSTAR

ETA-0.645   ******TSTAR   *****(TSTAR**2)

COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE: ETA, SITE:SWITZERLAND

REFERENCE AREA: 2.32 M**2, FLUID: WATER ,SLOPE:40.DIFFUSE-LIGHT

CH

SITE = CH   COLLECTOR TYPE IEA- 1   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 1   NUMBER OF DATA POINTS

ID	NO	DATE	HOUR	I	IO/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	178. 8.14	5.48	11.6	0.88	14.4	12.50	0.0	-0.6	19.1	5.70	****	0.6	0.0
1	2	178. 8.14	5.54	12.4	0.88	14.5	12.50	0.0	-0.6	19.1	5.33	****	0.5	0.0
1	2	178. 8.14	5.54	12.4	0.88	14.5	12.50	0.0	-0.6	19.1	6.36	****	0.5	0.0
1	4	178. 8.14	6.06	11.1	0.87	14.5	12.60	0.0	-0.5	19.1	5.87	****	0.5	0.0
1	5	178. 8.14	6.12	12.0	0.88	14.5	12.60	0.0	-0.5	19.1	5.44	****	0.5	0.0
1	6	178. 8.14	6.18	13.6	0.93	14.5	12.50	0.0	-0.5	19.1	4.87	****	1.2	0.0
1	7	178. 8.14	6.24	17.7	0.89	14.4	12.50	0.0	-0.5	19.1	3.71	-.74	0.7	0.0
1	8	178. 8.14	6.30	18.4	0.90	14.4	12.60	0.0	-0.5	19.1	3.51	-.72	0.7	0.0
1	9	178. 8.14	6.36	21.6	0.91	14.5	12.60	0.0	-0.5	19.2	3.04	-.59	0.8	0.0
1	10	178. 8.14	6.42	21.6	0.92	14.5	12.60	0.0	-0.4	19.2	3.05	-.54	0.9	0.0
1	11	178. 8.14	6.48	29.6	0.92	14.5	12.60	0.0	-0.3	19.2	2.24	-.32	0.9	0.0
1	12	178. 8.14	6.54	32.1	0.91	14.4	12.60	0.0	-0.3	19.3	2.07	-.26	1.0	0.0
1	13	178. 8.14	7.00	32.5	0.93	14.4	12.70	0.0	-0.3	19.3	2.02	-.25	1.0	0.0
1	14	178. 8.14	7.06	31.5	0.92	14.5	12.70	0.0	-0.3	19.3	2.08	-.25	1.0	0.0
1	15	178. 8.14	7.12	34.5	0.92	14.4	12.80	0.0	-0.2	19.3	1.88	-.20	0.6	0.0
1	16	178. 8.14	7.18	34.7	0.91	14.4	12.90	0.0	-0.2	19.4	1.88	-.13	0.5	0.0
1	17	178. 8.14	7.24	35.6	0.92	14.4	13.00	0.0	-0.1	19.5	1.81	-.08	0.4	0.0
1	18	178. 8.14	7.30	41.6	0.93	14.4	13.10	0.0	-0.1	19.5	1.53	-.04	0.4	0.0
1	19	178. 8.14	7.36	54.5	0.96	14.4	13.10	0.0	0.1	19.5	1.18	0.03	0.5	0.0
1	20	178. 8.14	7.42	69.4	0.94	14.4	13.10	0.0	0.4	19.7	0.95	0.14	0.6	0.0
1	21	178. 8.14	7.48	76.0	0.92	14.4	13.20	0.0	0.5	19.8	0.86	0.19	1.0	0.0
1	22	178. 8.14	7.54	83.1	0.94	14.4	13.30	0.0	0.6	19.8	0.78	0.20	0.6	0.0
1	23	178. 8.14	8.00	110.9	0.94	13.8	13.20	0.0	1.0	19.5	0.60	0.23	1.1	0.0
1	24	178. 8.14	8.06	109.6	0.93	14.0	13.30	0.0	1.1	20.0	0.61	0.27	0.9	0.0
1	25	178. 8.14	8.12	112.4	0.94	14.0	13.30	0.0	1.2	20.0	0.60	0.28	1.3	0.0
1	26	178. 8.14	8.18	122.9	0.93	14.1	13.20	0.0	1.4	20.1	0.56	0.29	1.2	0.0
1	27	178. 8.14	8.24	123.7	0.93	14.2	13.40	0.0	1.4	20.1	0.54	0.32	1.2	0.0
1	28	178. 8.14	8.30	128.7	0.93	14.1	13.70	0.0	1.5	20.3	0.51	0.33	0.8	0.0
1	29	178. 8.14	8.36	129.9	0.90	14.1	13.90	0.0	1.6	20.5	0.51	0.33	0.9	0.0
1	30	178. 8.14	8.42	144.0	0.94	14.1	14.10	0.0	1.7	20.6	0.45	0.33	1.0	0.0
1	31	178. 8.14	8.48	154.9	0.94	14.1	14.20	0.0	2.0	20.8	0.43	0.34	1.3	0.0
1	32	178. 8.14	8.54	165.4	0.93	14.1	14.40	0.0	2.2	20.9	0.39	0.36	0.8	0.0
1	33	178. 8.14	9.00	168.7	0.93	14.1	14.90	0.0	2.3	21.1	0.37	0.37	0.6	0.0
1	34	178. 8.14	9.06	166.6	0.92	14.0	14.80	0.0	2.4	21.1	0.38	0.38	0.8	0.0
1	35	178. 8.14	9.12	183.6	0.92	14.0	15.20	0.0	2.6	21.2	0.33	0.37	0.5	0.0
1	36	178. 8.14	9.18	194.5	0.92	14.0	15.40	0.0	2.8	21.3	0.30	0.39	0.7	0.0
1	37	178. 8.14	9.24	213.1	0.92	14.0	15.60	0.0	3.1	21.6	0.28	0.39	0.7	0.0
1	38	178. 8.14	9.30	205.9	0.92	14.0	15.70	0.0	3.3	21.6	0.29	0.43	0.6	0.0
1	39	178. 8.14	9.36	194.4	0.93	14.0	15.70	0.0	3.2	21.6	0.30	0.44	0.6	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT   FOR DETAILS SEE APPENDIX A

ETA=0.0   0.0 *TSTAR

ETA=0.465   0.322*TSTAR   0.0 (TSTAR**2)

LEAST SQUARE FIT

ETA=0.465   -.322*TSTAR

COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : BSE/OUTDOOR ;SITE:GERMANY

REFERENCE AREA: 2.300 M**2, FLUID: WATER , SLOPE:45 DEGREE, JUELICH

D

SITE = 0 COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 4

ID	NO	DATE	HOUR		ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	177. 9.27	10.50	858.0	0.27	17.1	15.70	0.6	15.0	16.1	0.00	0.56	2.5	0.0
1	2	177. 9.27	0.0	857.0	0.28	17.1	15.60	0.7	15.0	16.2	0.01	0.56	2.5	0.0
1	3	177. 9.27	0.0	863.0	0.28	17.2	16.00	0.9	15.1	16.4	0.00	0.56	2.5	0.0
1	4	177. 9.27	11.30	875.0	0.28	17.3	16.90	10.2	15.0	17.7	0.01	0.55	2.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.560 0.0 *TSTAR

ETA=0.560 0.312*TSTAR 0.000(TSTAR**2)

THE AVERAGED ETA

ETAO= 0.5575

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : INDOOR/BSE ;SITE:GERMANY

REFERENCE AREA: 2.300 M**2; FLUID: WATER ; SLOPE:45 DEGREE, JUELICH

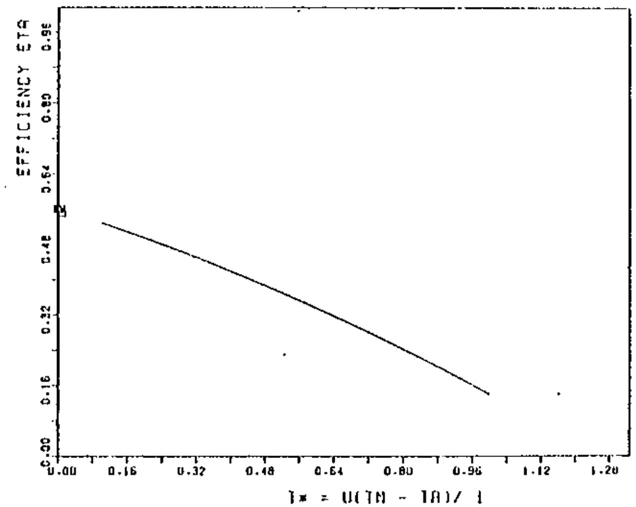
— I=800 WATT

X-MIN = 0.0000E0

X-MAX = 0.1200E1

Y-MIN = 0.0000E0

Y-MAX = 1.0000E0



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : INDOOR/BSE ,SITE:GERMANY

REFERENCE AREA: 2.300 M**2, FLUID: WATER , SLOPE:45 DEGREE, JUELICH

D

SITE = 0 COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 8

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.565- 0.31200*TSTAR- 0.10000E-03(TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
1	1	77.10.28	8.15	16.70	19.00	0.0	1.30	0.0	11.6	90.9	6.85	2.5	0.0	4186.7
1	2	77.10.28	8.30	16.51	19.50	0.0	1.25	0.0	10.9	86.7	7.92	2.5	0.0	4186.7
1	3	77.10.28	9.30	16.45	19.30	0.0	3.30	0.0	28.0	227.9	8.11	2.5	0.0	4186.7
1	4	77.10.28	10.00	16.64	19.50	0.0	3.30	0.0	27.8	230.6	8.27	2.5	0.0	4186.7
1	5	77.10.28	12.15	17.40	19.30	0.0	5.90	0.0	49.2	431.0	8.70	2.5	0.0	4186.7
1	6	77.10.28	12.45	17.30	19.40	0.0	5.90	0.0	49.0	429.0	8.70	2.5	0.0	4186.7
1	7	77.10.28	13.30	16.58	19.30	0.0	8.70	0.0	65.8	605.6	9.14	2.5	0.0	4186.7
1	8	77.10.28	14.00	16.54	19.60	0.0	8.70	0.0	65.5	604.0	9.18	2.5	0.0	4186.7

LEAST SQUARE FIT

ETA=0.565- 0.31222*TSTAR- 0.13718E-03(TSTAR**2)*I

THE CORRECTED ETAO

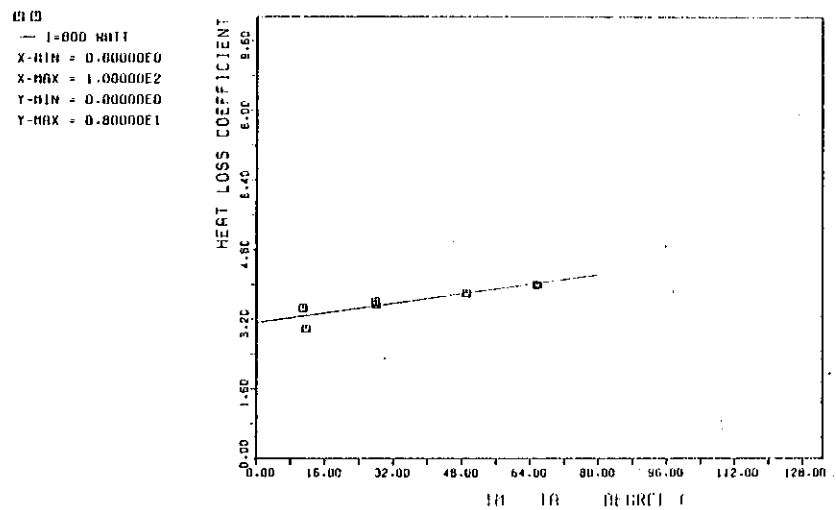
ETAO= 0.5620

LEAST SQUARE FIT

ETA=0.562- 0.31222*TSTAR- 0.13718E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : INDOOR/BSE ;SITE:GERMANY

REFERENCE AREA: 2.300 M**2; FLUID: WATER ; SLOPE:45 DEGREE, JUELICH



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : BSE/INDOOR ,SITE:GERMANY

REFERENCE AREA: 2.30 M**2, FLUID: WATER , SLOPE:45 DEGREE,HEIDELBERG

D

SITE = D COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 18

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.510- 0.26700*TSTAR- 0.16000E-03(TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	14.30	20.10	0.0	1.10	29.6	9.5	62.0	6.53	0.0	0.0	4186.7
1	2	0. 0. 0	0.0	13.80	20.80	0.0	2.30	39.0	18.2	126.0	6.92	0.0	0.0	4186.7
1	3	0. 0. 0	0.0	12.60	23.90	0.0	8.40	75.9	52.0	416.0	8.00	0.0	0.0	4186.7
1	4	0. 0. 0	0.0	20.50	24.20	0.0	5.50	77.4	53.2	441.0	8.29	0.0	0.0	4186.7
1	5	0. 0. 0	0.0	19.90	25.00	0.0	4.40	68.2	43.2	346.0	8.01	0.0	0.0	4186.7
1	6	0. 0. 0	0.0	19.60	23.20	0.0	6.90	86.0	62.8	526.0	8.38	0.0	0.0	4186.7
1	7	0. 0. 0	0.0	19.90	22.40	0.0	2.50	48.7	26.3	199.0	7.57	0.0	0.0	4186.7
1	8	0. 0. 0	0.0	20.30	22.40	0.0	1.50	39.4	17.0	122.0	7.18	0.0	0.0	4186.7
1	9	0. 0. 0	0.0	20.30	22.50	0.0	0.60	30.2	7.7	51.0	6.62	0.0	0.0	4186.7
1	10	0. 0. 0	0.0	20.10	22.50	0.0	3.60	58.3	35.8	289.0	8.07	0.0	0.0	4186.7
1	11	0. 0. 0	0.0	20.60	19.40	0.0	0.50	25.4	6.0	48.0	8.00	0.0	0.0	4186.7
1	12	0. 0. 0	0.0	20.40	20.10	0.0	1.30	34.8	14.7	105.0	7.14	0.0	0.0	4186.7
1	13	0. 0. 0	0.0	20.50	20.90	0.0	2.10	43.0	22.1	172.0	7.78	0.0	0.0	4186.7
1	14	0. 0. 0	0.0	20.00	22.10	0.0	3.00	53.1	31.0	241.0	7.77	0.0	0.0	4186.7
1	15	0. 0. 0	0.0	19.60	23.40	0.0	4.10	62.7	39.3	320.0	8.14	0.0	0.0	4186.7
1	16	0. 0. 0	0.0	19.30	24.50	0.0	5.30	72.5	48.0	402.0	8.38	0.0	0.0	4186.7
1	17	0. 0. 0	0.0	19.10	24.50	0.0	6.50	82.0	57.5	488.0	8.49	0.0	0.0	4186.7
1	18	0. 0. 0	0.0	18.80	25.40	0.0	7.20	86.8	61.4	525.0	8.55	0.0	0.0	4186.7

LEAST SQUARE FIT

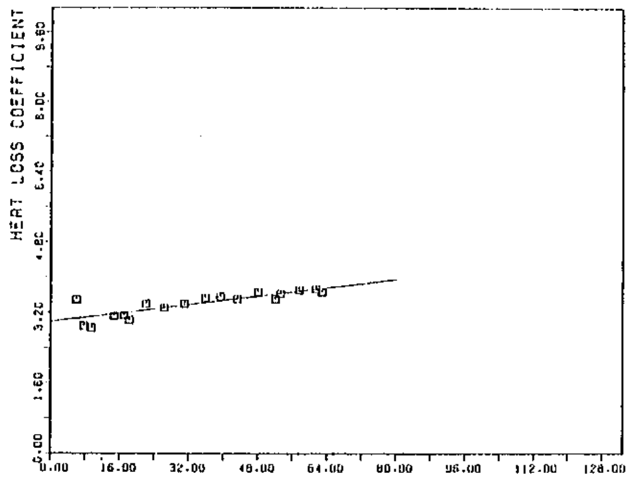
ETA=0.510- 0.29878*TSTAR- 0.12010E-03(TSTAR**2)*I

THE CORRECTED ETAO

ETAO= 0.5049

LEAST SQUARE FIT

ETA=0.505- 0.29878*TSTAR- 0.12010E-03(TSTAR**2)*I



COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : BSE/OUTDOOR ;SITE:GERMANY
REFERENCE AREA: 2.30 M**2; FLUID: WATER ; SLOPE:VARIABLE ,HEIDELBERG

D

SITE = D COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 6

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	0. 0. 0	0.0	813.0	0.0	64.0	18.86	0.0	3.4	28.8	0.12	0.45	4.0	0.0
1	2	0. 0. 0	0.0	862.0	0.0	62.9	20.40	0.0	3.6	29.3	0.10	0.45	4.0	0.0
1	3	0. 0. 0	0.0	663.0	0.0	34.2	18.50	0.0	5.8	20.9	0.04	0.53	4.0	0.0
1	4	0. 0. 0	0.0	715.0	0.0	44.9	19.30	0.0	4.7	20.4	0.02	0.52	4.0	0.0
1	5	0. 0. 0	0.0	714.0	0.0	46.1	19.60	0.0	4.4	20.2	0.01	0.49	4.0	0.0
1	6	0. 0. 0	0.0	776.0	0.0	44.7	20.40	0.0	4.9	20.5	0.00	0.49	4.0	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

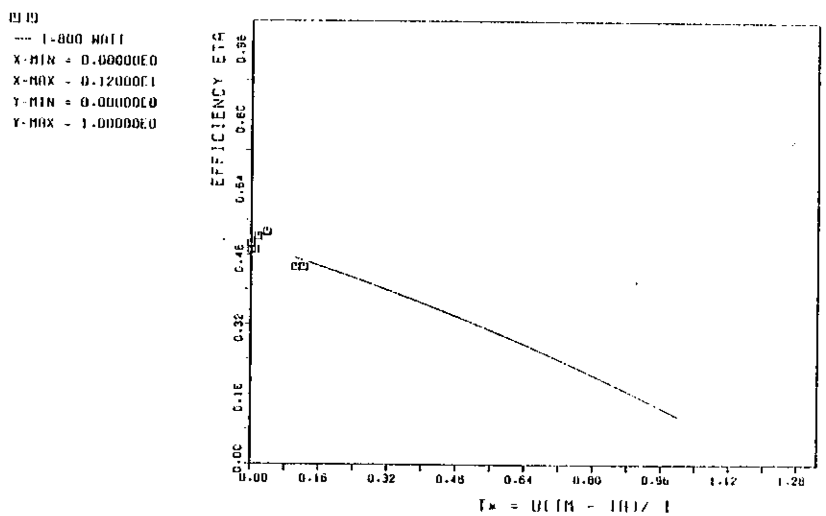
ETA=0.510 0.0 *TSTAR

ETA=0.510 0.267*TSTAR 0.000(TSTAR**2)

THE AVERAGED ETA

ETAO= 0.4883

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:GERMANY
REFERENCE AREA: 2.30 M**2; FLUID: WATER ; SLOPE:45 DEGREE,HEIDELBERG



COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:DENMARK

REFERENCE AREA: 2.32 M**2; FLUID: WATER ; SLOPE:45 DEGREE,COPENHAGEN

DK

SITE = DK COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 3

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.620- 0.36000*TSTAR- 0.17000E-03(TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	11.5	102.0	8.87	5.0	0.0	4186.7
1	2	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	29.5	278.0	9.42	5.0	0.0	4186.7
1	3	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	46.7	477.0	10.21	5.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.620- 0.36627*TSTAR- 0.16655E-03(TSTAR**2)*I

THE CORRECTED ETAO

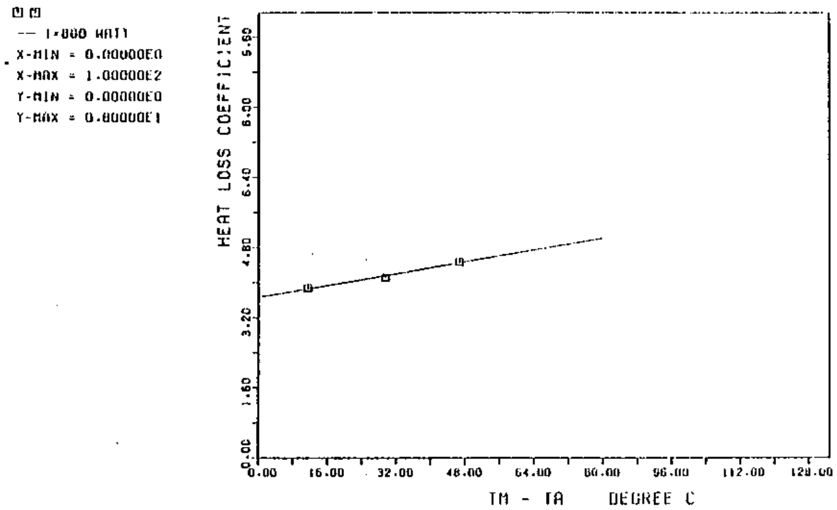
ETAO= 0.6299

LEAST SQUARE FIT

ETA=0.630- 0.36627*TSTAR- 0.16655E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:DENMARK

REFERENCE AREA: 2.32 M**2; FLUID: WATER ; SLOPE:45 DEGREE,COPENHAGEN



COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE :OUTDOOR/LOSS ;SITE: SPAIN

REFERENCE AREA: 2.31 M**2; FLUID: WATER ; SLOPE:45 DEGREE. MADRID

E

SITE = E COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 8

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.551- 0.0 *TSTAR- 0.0 (TSTAR**2)*)

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	16.0	130.0	8.13	0.0	0.0	4186.7
1	2	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	22.2	190.0	8.56	0.0	0.0	4186.7
1	3	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	25.0	212.0	8.48	0.0	0.0	4186.7
1	4	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	30.0	232.0	7.73	0.0	0.0	4186.7
1	5	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	39.0	320.0	8.21	0.0	0.0	4186.7
1	6	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	43.8	340.0	7.76	0.0	0.0	4186.7
1	7	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	49.4	398.0	8.06	0.0	0.0	4186.7
1	8	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	52.8	449.0	8.50	0.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.551- 0.36210*TSTAR--0.14316E-04(TSTAR**2)*(

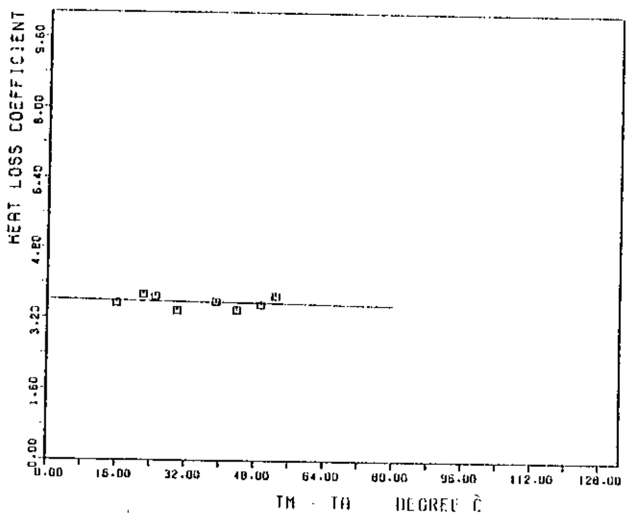
LEAST SQUARE FIT

ETA=0.551- 0.36210*TSTAR--0.14316E-04(TSTAR**2)*)

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE :OUTDOOR/LOSS ;SITE: SPAIN

REFERENCE AREA: 2.31 M**2; FLUID: WATER ; SLOPE:45 DEGREE. MADRID

— 1=000 WATT
X-MIN = 0.00000E0
X-MAX = 1.00000E2
Y-MIN = 0.00000E0
Y-MAX = 0.80000E1



COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : BSE/OUTDOOR ;SITE:DENMARK
REFERENCE AREA: 2.32 M**2; FLUID: WATER ; SLOPE:45 DEGREE,COPENHAGEN

DK

SITE = DK COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 12

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	77. 8. 2	11.15	961.0	0.23	35.8	21.80	0.0	9.2	25.4	0.04	0.62	4.0	-7.5
1	2	77. 8. 2	11.30	951.0	0.23	35.8	21.70	0.0	9.1	25.4	0.04	0.63	4.0	-7.5
1	3	77. 8. 2	11.45	944.0	0.23	35.8	21.60	0.0	9.0	25.3	0.04	0.62	4.0	-7.5
1	4	77. 8. 2	12.00	976.0	0.22	35.8	22.00	0.0	9.3	25.5	0.04	0.63	4.0	-7.5
1	5	77. 8. 2	12.15	984.0	0.23	35.8	22.30	0.0	9.5	25.5	0.03	0.63	4.0	-7.5
1	6	77. 8. 2	12.30	980.0	0.24	35.8	22.20	0.0	9.4	25.5	0.03	0.63	4.0	-7.5
1	7	77. 8. 5	11.15	898.0	0.33	41.8	21.30	0.0	7.0	27.8	0.07	0.59	4.0	-7.5
1	8	77. 8. 5	11.30	907.0	0.33	41.5	21.60	0.0	7.1	27.8	0.07	0.59	4.0	-7.5
1	9	77. 8. 5	11.45	898.0	0.35	41.3	21.60	0.0	7.1	27.8	0.07	0.59	4.0	-7.5
1	10	77. 8. 5	12.00	916.0	0.43	41.2	21.50	0.0	7.3	28.0	0.07	0.60	4.0	-7.5
1	11	77. 8. 5	12.15	918.0	0.37	41.0	21.60	0.0	7.4	28.0	0.07	0.61	4.0	-7.5
1	12	77. 8. 5	12.30	886.0	0.40	41.0	21.70	0.0	7.3	27.9	0.07	0.61	4.0	-7.5

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

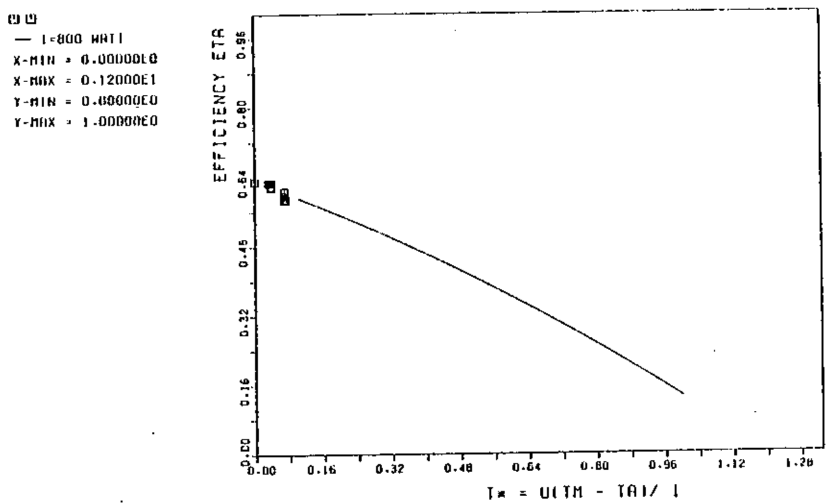
ETA=0.620 0.440*TSTAR

ETA=0.620 0.360*TSTAR 0.000(TSTAR**2)

THE AVERAGED ETA

ETAO= 0.6025

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : BSE/INDOOR ;SITE:DENMARK
REFERENCE AREA: 2.32 M**2; FLUID: WATER ; SLOPE:45 DEGREE,COPENHAGEN



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE :OUTDOOR/LOSS ,SITE:GREAT B.

REFERENCE AREA: 2.315 M**2, FLUID: WATER , SLOPE:45 DEGREE.CARDIFF

GB

SITE = GB   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2   NUMBER OF DATA POINTS = 13

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.550- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

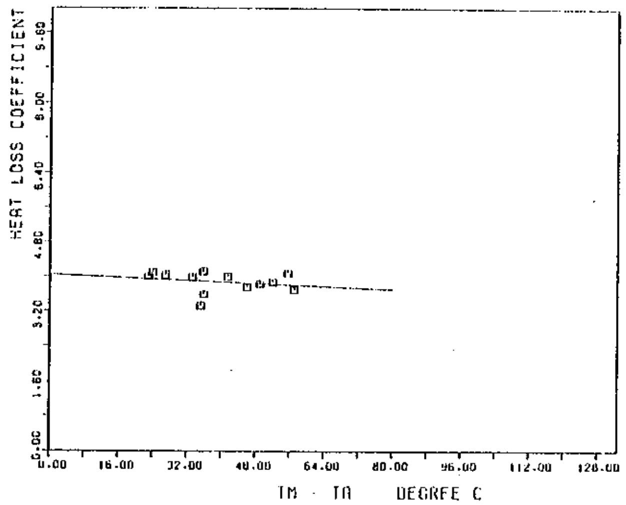
ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	23.0	211.0	9.17	0.0	0.0	4186.7
1	2	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	24.0	225.0	9.38	0.0	0.0	4186.7
1	3	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	27.0	250.0	9.26	0.0	0.0	4186.7
1	4	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	33.3	304.0	9.13	0.0	0.0	4186.7
1	5	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	35.2	268.0	7.61	0.0	0.0	4186.7
1	6	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	35.9	295.0	8.22	0.0	0.0	4186.7
1	7	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	35.8	337.0	9.41	0.0	0.0	4186.7
1	8	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	41.5	380.0	9.16	0.0	0.0	4186.7
1	9	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	46.0	395.0	8.59	0.0	0.0	4186.7
1	10	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	49.0	430.0	8.78	0.0	0.0	4186.7
1	11	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	52.0	460.0	8.85	0.0	0.0	4186.7
1	12	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	55.5	518.0	9.33	0.0	0.0	4186.7
1	13	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	57.0	482.0	8.46	0.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.550- 0.40451*TSTAR--0.43102E-04(TSTAR**2)*I

LEAST SQUARE FIT

ETA=0.550- 0.40451*TSTAR--0.43102E-04(TSTAR**2)*I



COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE :OUTDOOR/LOSS ;SITE: JAPAN

REFERENCE AREA: 2.297 M**2; FLUID: WATER ; SLOPE:38 DEGREE, NAGOYA

J

SITE = J COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 5

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.564- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	8.6	55.0	6.40	0.0	0.0	4186.7
1	2	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	20.4	160.0	7.84	0.0	0.0	4186.7
1	3	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	39.5	310.0	7.85	0.0	0.0	4186.7
1	4	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	57.5	495.0	8.61	0.0	0.0	4186.7
1	5	0. 0. 0	0.0	0.0	0.0	0.0	0.0	0.0	70.5	665.0	9.43	0.0	0.0	4186.7

LEAST SQUARE FIT

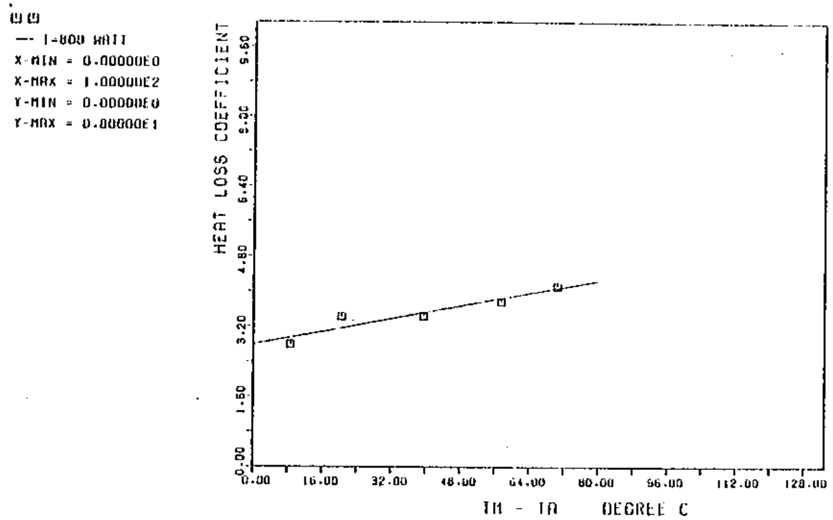
ETA=0.564- 0.27931*TSTAR- 0.18104E-03(TSTAR**2)*I

LEAST SQUARE FIT

ETA=0.564- 0.27931*TSTAR- 0.18104E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE :OUTDOOR/LOSS ;SITE: JAPAN

REFERENCE AREA: 2.297 M**2; FLUID: WATER ; SLOPE:38 DEGREE, NAGOYA



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : BSE/OUTDOOR ,SITE:NETHERL

REFERENCE AREA: 2.315 M**2, FLUID: WATER , SLOPE:45 DEGREE. DELFT

NL

SITE = NL COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 4

ID	NO	DATE	HOUR	I	ID/I	FLOW	TA	TI	DELTAT	TM	T*	ETA	WIND	TSKY
1	1	177. 5.25	13.00	969.0	0.13	28.6	19.70	0.0	10.6	20.7	0.01	0.57	8.5	0.0
1	2	177. 5.25	14.00	955.0	0.13	28.7	19.80	0.0	10.2	22.6	0.03	0.56	8.5	0.0
1	3	177. 5.25	14.30	944.0	0.13	28.7	20.70	0.0	9.8	24.9	0.05	0.54	8.5	0.0
1	4	177. 5.25	15.15	935.0	0.13	28.6	20.90	0.0	9.4	29.8	0.10	0.53	8.5	0.0

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.560 0.0 *TSTAR

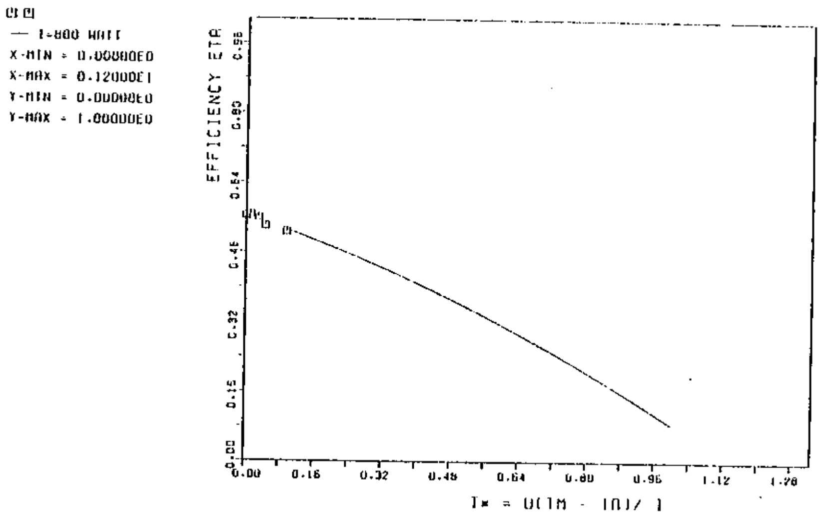
ETA=0.560 0.0 *TSTAR 0.0 (TSTAR**2)

THE AVERAGED ETA

ETAO= 0.5432

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : INDOOR/BSE ;SITE:NETHERL

REFERENCE AREA: 2.315 M**2; FLUID: WATER ; SLOPE:45 DEGREE. DELFT



COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : INDOOR/BSE ;SITE:NETHERL

REFERENCE AREA: 2.315 M**2; FLUID: WATER , SLOPE:45 DEGREE. DELFT

NL

SITE = NL COLLECTOR TYPE IEA- 2 TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2 NUMBER OF DATA POINTS = 4

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.560- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	26.30	21.80	0.0	0.29	26.2	4.4	31.9	7.25	5.0	0.0	4186.7
1	2	0. 0. 0	0.0	27.20	23.10	0.0	0.97	36.3	13.2	110.0	8.33	5.0	0.0	4186.7
1	3	0. 0. 0	0.0	27.40	22.60	0.0	2.44	54.1	31.5	278.0	8.83	5.0	0.0	4186.7
1	4	0. 0. 0	0.0	26.90	23.10	0.0	3.98	71.0	47.9	449.0	9.37	5.0	0.0	4186.7

LEAST SQUARE FIT

ETA=0.560- 0.32217*TSTAR- 0.19231E-03(TSTAR**2)*I

THE CORRECTED ETA0

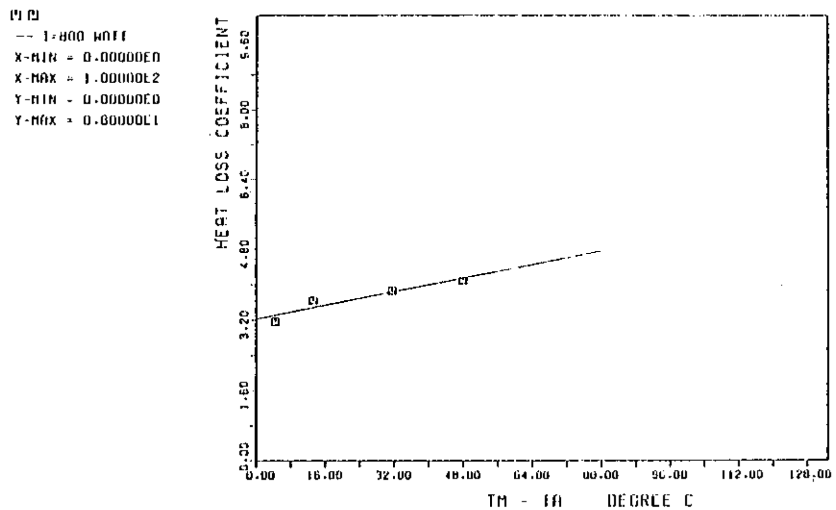
ETA0= 0.5636

LEAST SQUARE FIT

ETA=0.564- 0.32217*TSTAR- 0.19231E-03(TSTAR**2)*I

COLLECTOR TYPE: IEA-2 ; TESTING PROCEDURE : INDOOR/BSE ;SITE:NETHERL

REFERENCE AREA: 2.315 M**2; FLUID: WATER ; SLOPE:45 DEGREE. DELFT



COLLECTOR TYPE: IEA-2 , TESTING PROCEDURE : INDOOR/BSE ,SITE: USA

REFERENCE AREA: 2.290 M**2, FLUID: WATER , SLOPE:27 DEGREE. NBS

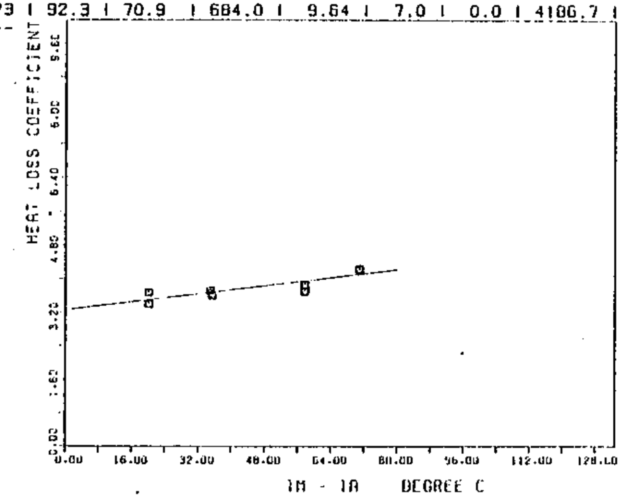
USA

SITE = USA   COLLECTOR TYPE IEA- 2   TEST-PROCEDURE (ASHRAE/BSE = 1/2) = 2   NUMBER OF DATA POINTS = 16

THE AUTHOR HAS GIVEN THE FOLLOWING DATA FIT

ETA=0.583- 0.0 *TSTAR- 0.0 (TSTAR**2)*I

ID	NO	DATE	HOUR	FLOW	TA	TI	DELTAT	TM	TM-TA	QL	UM*AREA	WIND	TSKY	C-P
1	1	0. 0. 0	0.0	45.30	20.59	40.3	0.83	40.8	20.2	157.0	7.77	7.2	0.0	4186.7
1	2	0. 0. 0	0.0	45.30	20.68	40.3	0.90	40.8	20.1	170.0	8.45	8.0	0.0	4186.7
1	3	0. 0. 0	0.0	45.30	20.83	40.4	0.89	40.8	20.0	168.0	8.39	6.9	0.0	4186.7
1	4	0. 0. 0	0.0	45.10	20.79	40.4	0.89	40.9	20.0	156.0	7.80	6.7	0.0	4186.7
1	5	0. 0. 0	0.0	44.80	20.89	55.5	1.56	56.3	35.4	292.0	8.25	9.0	0.0	4186.7
1	6	0. 0. 0	0.0	44.80	20.96	55.4	1.57	56.2	35.3	294.0	8.34	10.2	0.0	4186.7
1	7	0. 0. 0	0.0	44.80	21.14	55.4	1.60	56.2	35.1	300.0	8.56	9.5	0.0	4186.7
1	8	0. 0. 0	0.0	44.80	21.42	55.3	1.58	56.1	34.7	296.0	8.52	8.1	0.0	4186.7
1	9	0. 0. 0	0.0	44.40	21.69	78.1	2.65	79.4	57.8	492.0	8.52	7.4	0.0	4186.7
1	10	0. 0. 0	0.0	44.40	21.88	78.1	2.62	79.4	57.6	487.0	8.46	7.0	0.0	4186.7
1	11	0. 0. 0	0.0	44.60	21.82	78.0	2.74	79.4	57.6	512.0	8.89	8.5	0.0	4186.7
1	12	0. 0. 0	0.0	44.40	21.67	78.0	2.75	79.4	57.7	511.0	8.85	9.9	0.0	4186.7
1	13	0. 0. 0	0.0	43.80	21.39	90.3	3.75	92.2	70.8	688.0	9.72	7.8	0.0	4186.7
1	14	0. 0. 0	0.0	43.90	21.44	90.4	3.71	92.3	70.8	682.0	9.63	8.5	0.0	4186.7
1	15	0. 0. 0	0.0	43.90	21.34	90.4	3.76	92.3	70.9	691.0	9.74	9.9	0.0	4186.7
1	16	0. 0. 0	0.0	43.80	21.54	90.4	3.73	92.3	70.9	684.0	9.64	7.0	0.0	4186.7



LEAST SQUARE FIT

ETA=0.583- 0.32530*TSTAR- 0.12070E-03(TSTAR**2)*I

LEAST SQUARE FIT

ETA=0.583- 0.32530*TSTAR- 0.12070E-03(TSTAR**2)*I