

GasCooler Manual

This Application is used to simulate vertical Water-cooled Shell and Tube Heat Exchangers operating in either Counter-current or Co-current Mode and with the Gas Flow moving in the Downwards Direction

The Gas is composed by a Mixture of H₂O, O₂, N₂, CO₂, CO, H₂ and CH₄, defined by their volumetric Composition, Inlet Temperature and Pressure. Depending on the Input Data, the Gas will be cooled either in non-condensing or condensing Mode - in the latter Case, the Amount of H₂O Condensate is calculated

The Heat Exchanger is defined by the characteristic Pattern Size and the Number of Shell-side Passes used. Further Input Data are the Tube external Diameter, the Tube-wall Gauge, the Material Conductivity, the Pitch/Diameter Ratio and the Length of a single Shell-side Pass

The Programme was developed by **TEISLEVenergy** during the Winter 2006 and Problems related to this beta-version may be addressed to:

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The Manual is comprised of the following Parts:

- ?? Pick the slider using the mouse left button to move the slider
- ?? Click the white field inside the control (left/right of slider) for large steps
- ?? Click the arrows of the slider for smaller Steps

After adjusting the entries, You must click the "UPDATE Heat Exchanger" button to perform the simulation

SIZE (-) = Tube bundle pattern size

In the opening screen, You will notice the number "8", which is reflected as the "edge length" in the bundle layout sketch. For the layout shown, You will also notice some "extra" tubes (marked red), which are made possible for the selected tube diameter and tube pitch – observing a constant clearance around all tubes. In GasCooler the Limits for SIZE are set as 4 and 16

PASSES (-) = Number of shell-side cross-flow passes

In the opening screen, You will notice the number "8", which is reflected in the layout sketch at the screen upper right. It should be noted that all passes have equal length. In GasCooler the limits for PASSES are set as 4 and 24

Tube Diam. (mm) = Heat exchanger tube external diameter

In GasCooler the limits for the tube external diameter are set as 12.0 and 50.0 mm – it is initially set to 25.0 mm

Tube Gauge (mm) = Heat exchanger tube wall thickness

In GasCooler the Limits for the tube wall thickness are set as 1.0 and 5.0 mm – it is initially set to 2.0 mm

Pitch Ratio (-) = Ratio of tube pitch to tube external diameter

The heat exchanger tubes are arranged in a uniform hexagonal pattern and in GasCooler the limits for the pitch ratio are set as 1.10 and 1.50 – it is initially set to 1.25

Material (W/mK) = Tube material thermal conductivity

In GasCooler the limits for the thermal conductivity are set as 20 and 200 (W/mK) – it is initially set to 60 W/mK

Pass Length (mm) = Uniform distance between the baffle plates

In GasCooler the limits for the baffle plate distance are set as 100 and 500 mm – it is initially set to 250 mm

Gas Pressure (kPa) = Gas pressure at heat exchanger (top) gas inlet

The pressure is measured in kPa, where 1 bar = 100 kPa. In GasCooler the limits for gas inlet pressure are set as 80.0 and 160.0 (kPa) – initially the value is 101.3 kPa (i.e. atmospheric standard pressure)

Temperature (C) = Gas temperature at heat exchanger (top) gas inlet

The temperature is measured in degrees centigrade. In GasCooler the limits for gas inlet temperature are set as 80.0 and 240.0 (C) – initially the value is 110.0 C

and Flow (kg/s) = Gas inlet flow rate at heat exchanger (top) inlet

The flow rate is measured in kg/s and in GasCooler the limits for gas flow rate are set as 0.100 and 2.000 (kg/s) – initially the value is 0.400 kg/s

Water at Top (C) = Water temperature at top water nozzle

The temperature is measured in degrees centigrade. In GasCooler the limits for top nozzle water temperature are set as 40.0 and 80.0 (C) – initial value is 50.0 C

and Flow (kg/s) = Cooling water flow rate throughout the heat exchanger

The flow rate is measured in kg/s and in GasCooler the limits for water flow rate are set as 1.00 and 10.00 (kg/s) – initially the value is 2.00

Finally, You can select one of the option buttons “Counter-current” or “Co-current”. After subsequently clicking “UPDATE Heat Exchanger”, You will notice, that the water flow arrow in the sketch of the upper right part of the screen will change and also the performance will be adjusted to the new flow direction

GAS COMPOSITION (volume %)

In this input field the volumetric composition of the mixture of H₂O, O₂, N₂, CO₂, CO, H₂ and CH₄ is defined. The values in the fields are adjusted in the range 0.0 to 100.0 and after clicking “UPDATE GAS COMPOSITION”, the calculation will be carried out using the new data. If (for some reason) the total does not add up to 100%, the values are normalized to this and the numbers displayed are adjusted

THE OUTPUT FIELDS

Data table in upper left corner (for every 5 calculation steps)

As described in the theory part of the manual, the heat exchanger is divided uniformly into 100 steps, and the 13 columns of this table provide important information for every 5 steps. In the following, the data in the row labeled 100 will be commented:

- Z (mm):** Distance from top gas inlet – 100 mm from top
- Tw (C):** Coolant water temperature – 48.3 (C)
- Tg (C):** Gas bulk temperature at the location – 101.2 (C)
- dQdZ (kW/m):** Tube bundle heat rate – 165.8 (kW/m)
- dPdZ (Pa/m):** Local pressure drop gradient – 166.7 (Pa/m)
- H₂O (kg/s):** Condensate flow rate – 0.00440 (kg/s)
- Tdew (C):** Dew point – 63.2 (C)
- H₂O (%):** Local volumetric fraction for H₂O – 22.8 (%)
- O₂ (%):** Local volumetric fraction for O₂ – 16.3 (%)
- N₂ (%):** Local volumetric fraction for N₂ – 61.0 (%)
- CO₂ (%):** Local volumetric fraction for CO₂ – 0.0 (%)
- CO (%):** Local volumetric fraction for CO – 0.0 (%)
- H₂ (%):** Local volumetric fraction for H₂ – 0.0 (%)
- CH₄ (%):** Local volumetric fraction for CH₄ – 0.0 (%)

At the bottom of the table (i.e. the heat exchanger exit), we find the corresponding data for the exit nozzles:

- Z (mm):** Distance from top gas inlet – EXIT – i.e. 2000 mm from top
- Tw (C):** Coolant water temperature – 31.6 (C)

Tg (C): Gas bulk temperature at the location – 38.4 (C)
dQdZ (kW/m): Tube bundle heat rate –19.4 (kW/m)
dPdZ (Pa/m): Local pressure drop gradient – 101.3 (Pa/m)
H2O (kg/s): Condensate flow rate – 0.05193 (kg/s)
Tdew (C): Dew point – 37.2 (C)
H2O (%): Local volumetric fraction for H2O – 6.3 (%)
O2 (%): Local volumetric fraction for O2 – 19.7 (%)
N2 (%): Local volumetric fraction for N2 – 74.0 (%)
CO2 (%): Local volumetric fraction for CO2 – 0.0 (%)
CO (%): Local volumetric fraction for CO – 0.0 (%)
H2 (%): Local volumetric fraction for H2 – 0.0 (%)
CH4 (%): Local volumetric fraction for CH4 – 0.0 (%)

Heat exchanger general layout and misc'l data in upper right corner

The heat exchanger layout sketch shows the gas (0.400 kg/s at the Inlet) being cooled from 110.0 (C) to 38.4 (C) in counter-flow with water (2.00 kg/s) heated from 31.6 (C) to 50.0 (C). The arrow at the left of the field indicates counter-current operation.

The water condensate rate is indicated as 0.05193 kg/s and the overall gas side pressure drop is 248 (Pa). It should be noticed, that the pressure drop calculation is based on a calculation for a smooth tube, and that ripples on the condensate film surface are not taken into account.

Furthermore, the total heat transfer is indicated as 154.1 (kW).

Tube bundle layout and misc'l data in lower right corner

The general hexagonal arrangement (with the pattern size 8 used here) in itself contains 169 tubes and the tube count indicated (187) accounts for the extra 18 tubes (marked with red), which can be fitted into the shell (having an internal diameter of 469 mm). Also the tube dimension (25.0 mm external diameter and 2.0 mm wall thickness s indicated – together with the length of 2000 mm.

GasCooler Theory

OVERVIEW

Throughout this section, consistent SI-Units are used (even if GasCooler sometimes – internally – uses more practical engineering units).

BASIC GEOMETRY

The heat exchanger tubes are defined by their external diameter **D** (m), the wall thickness **gauge** (m) and the length **Lpass * passes** (m) where **Lpass** (m) is the uniform cross flow length and **passes** the number of cross flow passes. The tube material is specified through the thermal conductivity **lambda** (W/mK).

The tube bundle is comprised of **nT** tubes, where the fundamental hexagonal pattern contains **nT0** tubes ($= 3 * \mathbf{SIZE}^2 - 3 * \mathbf{SIZE} + 1$), where **SIZE** is the characteristic pattern size). The difference between **nT** and **nT0** is the number of

extra tubes, which it is possible – through geometrical considerations – to fit inside the external shell.

In GasFlow, The external shell diameter $D_0 = \text{layers} * D * \text{pitch}$ (m), where **pitch** is the ratio between the uniform tube layout pitch and the tube external diameter and **layers** is the number of tube layers in the uniform hexagonal bundle: $\text{layers} = 2 * \text{SIZE} - 1$

GAS AND WATER FLOW

The moist gas has an inlet flow rate of **flowG** (kg/s), which will decrease through condensation or remain constant (if the tube wall temperature everywhere is above the dew point of the local gas). The gas is flowing in a downwards direction to avoid slug flow pulsations caused by interaction with the condensate film. Based on the available flow area for the gas, a mass flux **fluxG** (kg/m²s) is calculated.

The gas at the inlet is composed of the 7 gases H₂O, O₂, N₂, CO₂, CO, H₂ and CH₄ – of which only H₂O is considered as condensable. The composition at the inlet (and throughout the heat exchanger) is designated **xG(0)** through **xg(7)**. The local inlet gas temperature and absolute pressure are **TG** (K) and **pG** (Pa), respectively.

The cooling water enters (shell-side) either through a top nozzle (co-current flow) or through a bottom nozzle (counter-current flow) at a temperature **TW** (K) and at a rate of **flowW** (kg/s). Based on the available flow area for the cooling water, a mass flux **fluxW** (kg/m²s) is calculated.

GENERAL HEAT EXCHANGER OPERATION

Where the dew point **Tsat** (K) for the gas exceeds the local tube wall temperature **Twi** (K), a condensate film will be formed – having a local temperature **TF** (K) and a thickness **film** (m). The external tube wall at a temperature **Twe** (K) will exchange heat with the cooling water.

If this condition prevails throughout the tubes, the condensate film will increase in a downward direction and finally be discharged at the bottom of the heat exchanger. If not, then the mechanism will be a dry cooling of the gas.

THERMO PHYSICAL DATA

The thermo physical model is based on: *Rohsenow, W.M., Hartnett, J.P. and Cho, Y.I.: Handbook of Heat Transfer, 3. Ed., McGraw-Hill 1998* and calculates specific heat **cp** (J/kgK), density **hro** (kg/m³), dynamic viscosity **vis** (kg/ms) and thermal conductivity **con** (W/mK) at gas temperature **TG** (K) and atmospheric pressure (101.3 kPa) – for other pressures, these data are subsequently adjusted. For H₂O the correlations are (as an example – using the Visual Basic language formulation):

```
cp = 1851.043 - 0.2959664 * T + 0.001325991 * T ^ 2 - 0.0000006893946 * T ^ 3 + 9.237505E-11 * T ^ 4
hro = 18.015 * 101325 / (8314.39 * T)
vis = 4.453609 - 0.003628572 * T + 0.00009277361 * T ^ 2 - 0.00000008121007 * T ^ 3 + 2.521054E-11 * T ^ 4
vis = vis / 1000000
con = 0.01900357 - 0.000006379829 * T + 0.0000002769922 * T ^ 2 - 0.000000000192144 * T ^ 3 + 5.729632E-14 * T ^ 4
```

For the condensation of H₂O in the tubes also the mass diffusivity **dif** (m²/s) for H₂O through a non-condensing gas mixture, is needed. For this purpose, the

Chapman-Enskog theory is applied (even if it is not precise – it is still the only approach, generally available). The theory – which is based on the critical properties for the participating species – is described in e.g. *Rohsenow, W.M., Hartnett, J.P. and Ganic, E.N.: Handbook of Heat Transfer Fundamentals, 2. Ed., McGraw-Hill 1985.*

For mixtures of the participating gases the Chapman-Enskog theory has been extended by Wilke (as described in e.g. *Bird, R.B., Stewart, W.E. and Lightfoot, E.N.: Transport Phenomena, John Wiley & Sons 1960*) for the calculation of the mixture properties for **cp**, **hro**, **con** and **con** (see above for definitions).

Similarly – for the cooling water – the following formulation is used (where also the heat of evaporation **HLV** (J/kg) is included):

$$\begin{aligned}
 cp &= 4217 - 3.197611 * T + 0.09534922 * T^2 - 0.001307996 * T^3 + 0.000009082309 * T^4 - 0.00000002348604 * T^5 \\
 cp &= 4217 - 2.765251 * T + 0.06433275 * T^2 - 0.000571916 * T^3 + 0.000002035775 * T^4 \\
 hro &= 999.8 + 0.07790002 * T - 0.009038839 * T^2 + 0.00008076718 * T^3 - 0.0000005944681 * T^4 + 0.000000001957738 * T^5 \\
 con &= 569 + 1.713422 * T + 0.003760926 * T^2 - 0.0002723581 * T^3 + 0.00000266643 * T^4 - 0.000000009124406 * T^5 \\
 5: con &= con / 1000 \\
 vis &= 7.467363 - 0.03217767 * T + 0.000238602 * T^2 - 0.000001569035 * T^3 + 0.000000007176725 * T^4 - 1.530001E-11 * T^5 \\
 vis &= 0.000001 * Exp(vis) \\
 HLV &= 2.501603 - 0.002402595 * T + 0.000003283337 * T^2 - 0.00000008762935 * T^3 + 8.296005E-10 * T^4 - 3.26212E-12 * T^5 \\
 HLV &= 1000000 * HLV
 \end{aligned}$$

HEAT AND MASS TRANSFER

The basic heat transfer processes in the calculation and the H2O film mass transfer will now be reviewed:

External tube heat transfer

Heat is transferred from the tube bundle surface at the local temperature **Twe** (K) to the cross-flow cooling water at temperature **Tw** (K) subject to a heat transfer coefficient **hE** (W/m2K). The water flow **flowW** (kg/s) has a corresponding mass flux designated by **fluxW** (kg/m2s) through the free (centerline) area **areaW** = **Lpass** * **layers** * (**pitch** – 1) * **D** – because the baffle plate are equidistant. It is obvious, that: **fluxW** = **flowW/areaW**.

The heat transfer coefficient is found according to e.g. *Incropera, F.P., and de Witt, D.P.: Fundamentals of Heat and Mass Transfer, Wiley&Sons (1990)*:

$$\begin{aligned}
 Nu &= cc * Re^{\text{mm}} * Pr^{0.36}, \text{ where:} \\
 Nu &= hE * D / con, Re = fluxW * D \text{ and: } Pr = vis * cp / con \\
 \text{Also, } cc \text{ and } mm &\text{ are empirical constants found from:} \\
 Re < 40: cc &= 0.750, mm = 0.40 \\
 40 < Re < 1000: cc &= 0.510, mm = 0.50 \\
 1000 < Re < 200000: cc &= 0.400, mm = 0.60 \\
 200000 < Re: cc &= 0.022, mm = 0.84
 \end{aligned}$$

The correlation with experimental data is quite good, when the thermo physical data for the water – at temperature **Tw** (K) – is evaluated from above mentioned functions. The Nusselt number (**Nu**), which is developed for a number of tube layers above 20, is finally corrected according to:

$$Nu = Nu * (1 - 0.457 * Exp(-0.239 * layers))$$

Internal tube heat transfer

Heat is transferred from the gas at the local temperature **TG** (K) to the tube surface at temperature **Twi** (K) – in the case of condensation, through a H2O film with a thickness of **film** (mm) at mean temperature **TF** (K).

The local gas flow **flowG** (kg/s) has a corresponding mass flux designated by **fluxG** (kg/m²s) through the **nT** tubes free flow area:

$$\text{areaG} = \pi / 4 * (\text{D}^2 - (\text{D} - 2 * \text{gauge})^2) * \text{nT0}, \text{fluxG} = \text{flowG}/\text{areaG}$$

For the heat transfer without condensation, the heat transfer coefficient **hI** (W/m²K) according to e.g. *Incropera, F.P., and de Witt, D.P.: Fundamentals of Heat and Mass Transfer, Wiley&Sons (1990)*:

$$\text{Nu} = (\text{fric} / 8) * (\text{Re} - 1000) * \text{Pr} / (1 + 12.7 * \text{Sqr}(\text{fric} / 8) * (\text{Pr}^{\wedge} 0.333 - 1)),$$

where: **Nu** = **hI** * (**D** - 2 * **gauge**)/**con**, **Re** = **fluxG** * (**D** - 2 * **gauge**)/**vis** and: **Pr** = **vis** * **cp**/**con**

The friction coefficient **fric** is found from: **fric** = 1 / (0.79 * Log(**Re**) - 1.64) ^ 2 and is further used to calculate the local gas side pressure drop gradient:

$$\text{dpdZ} = (0.5 * \text{fluxG}^2 / \text{hro}) * \text{fric} / (\text{D} - 2 * \text{gauge})$$

The correlations for the thermo physical data for the gas mixture at **TG** (K) and **pG** (Pa) are described previously.

The final heat transfer coefficient used for calculating the internal heat transfer rate is the H2O-condensate film heat transfer coefficient **hF** (W/m²K) at film temperature **TF** (K) and condensate film thickness **film** (m), where the calculation is based on: *Incropera, F.P., and de Witt, D.P.: Fundamentals of Heat and Mass Transfer, Wiley&Sons (1990)*

For **Re** < 30: **hF** = (**con** / **aux**) * 1.47 * **Re** ^ (-0.333), **Re** < 1800: **hF** = (**con** / **aux**) * **Re** / (1.08 * **Re** ^ 1.22 - 5.2) and for **Re** > 1800:

$$\text{hF} = (\text{con} / \text{aux}) * \text{Re} / (8750 + 58 * \text{Pr}^{\wedge} (-0.5) * (\text{Re}^{\wedge} 0.75 - 253))$$

The Reynolds and Prandtl numbers and the auxiliary constant for the film are defined by: **Re** = 4 * 9.816 * **hro** ^ 2 * **film** ^ 3 / (3 * **vis** ^ 2), **Pr** = **vis** * **cp**/**con** and **aux** = (**visF** ^ 2 / (**hroF** ^ 2 * 9.816)) ^ 0.333

The thermo physical data are evaluated at the film temperature using the previously described correlations for liquid water at temperature **TF**.

Film mass transfer

The mathematical model is based on the Chilton-Colburn analogy as described in e.g. *Treybal, R.E.: Mass Transfer Operations, McGraw-Hill 1980*.

The Chilton-Colburn analogy states, that for heat and mass transfer in geometric similar systems (here we consider the gas flowing internally in the tubes) the following is valid for the Stanton numbers:

$$\text{StHEAT} * \text{Pr}^{\wedge} .667 = \text{StMASS} * \text{Sc}^{\wedge} .667, \text{ where the Prandtl number: } \text{Pr} = \text{vis} * \text{cp}/\text{con} \text{ and the Scmidth number: } \text{Sc} = \text{vis}/(\text{hro} * \text{dif})$$

Furthermore, the 2 dimension-less numbers may be expressed by:

$$\text{StHEAT} = \text{Nu} / (\text{Re} * \text{Pr}) \text{ and } \text{StMASS} = \text{Mw} * \text{hM}/\text{fluxG}$$

$\text{Nu} = \text{hl} * (\text{D} - 2 * \text{gauge})/\text{con}$, $\text{Re} = \text{fluxG} * (\text{D} - 2 * \text{gauge})/\text{vis}$ and: $\text{Pr} = \text{vis} * \text{cp}/\text{con}$ as found previously, Mw (= 18.016 kg/kmol) is the H2O molar mass and hM (kmol/m2s of H2O) is the mass transfer coefficient, which may now be calculated using the previously described correlations for the thermo physical data.

The Condensate Film

The local H2O mass transfer at the film interface may be calculated from:
 mH2O (kg/m2s) = $\text{Mw} * \text{hM} * \text{LOGe}((\text{pG} - \text{psat}(\text{TF})) / (\text{pG} - \text{pH2O}))$, where:
 $\text{psat}(\text{TF})$ is the saturation pressure of H2O at film temperature TF and pH2O is the partial pressure of H2O in the gas: $\text{pH2O} = \text{xH2O} * \text{pG}$, xH2O being the local H2O molar fraction in the gas.

The condensate film Reynolds number may (as previously noticed) be expressed by:

$$\text{Re} = 4 * 9.816 * \text{hro} ^ 2 * \text{film} ^ 3 / (3 * \text{vis} ^ 2) \text{ or alternatively:}$$

$$\text{Re} = 4 * \text{film} * \text{hro} * \text{uH2O}/\text{vis}, \text{ where } \text{uH2O} \text{ (m/s) is the local film velocity}$$

The continuity requirement for the condensate film is:

$$\text{mH2O} \text{ (kg/s)} = \text{hro} * \text{[uH2O} * \text{film]} / \text{Z}$$

Combining these expressions:

$$\text{Re}/\text{Z} = 4 * \text{mH2O}/\text{vis}, \text{ uH2O} = \text{hro} * 9.816 * \text{film}^2 / (3 * \text{vis}) \text{ and } \text{film} * \text{uH2O} = 0.25 * \text{vis} * \text{Re}/\text{hro} \text{ and after some manipulations the film thickness for the next lower step:}$$

$$\text{film} = (3 * \text{vis} ^ 2 * (4 * \text{hro} ^ 2 * 9.816 * \text{film} ^ 3 / (3 * \text{vis} ^ 2) + 4 * \text{mH2O} * \text{dZ} / \text{vis}) / (4 * \text{hro} ^ 2 * 9.816)) ^ 0.333$$

Energy balance

The heat transfer rate from the gas mixture to the film surface is:

$$1. \text{ QGF} \text{ (W/m}^2\text{)} = \text{K} * \text{hl} * (\text{TG} - \text{TF}) + \text{mH2O} * \text{HLV}, \text{ where } \text{K} \text{ is the correction factor for simultaneous heat and mass transfer:}$$

$$\text{K} = \text{k} / (1 - \exp(-\text{k})), \text{ with: } \text{k} = \text{mH2O} * \text{cpH2O}/\text{hl}$$

In this formulation cpH2O (J/kgK) is the steam specific heat at temperature TF (K) and HLV (J/kg) is the heat of evaporation

The heat transfer rate from the film surface to the cooling water is:

$$2. \text{ QFW} \text{ (W/m}^2\text{)} = \text{Utot} * (\text{TF} - \text{TW}), \text{ where the total heat transfer coefficient is found from: } 1/(\text{Utot} * (\text{D} - 2 * \text{gauge})) = 1/(\text{hE} * \text{D}) + \text{LOGe}(\text{D}/(\text{D} - 2 * \text{gauge})) / (2 * \text{lambd}) + 1/(\text{hl} * (\text{D} - 2 * \text{gauge}))$$

Equations 1 and 2 are used to iteratively (by requesting QGF and QFW to be equal) to find the film temperature TF (K) and following this, all other relevant data for the simultaneous heat and mass transfer.

In the case, where no condensation occurs – i.e. when the gas H2O dew point is below the wall temperature – TF is exchanged with Tw (the internal wall temperature) and in equation 1 we get: $\text{QGW} \text{ (W/m}^2\text{)} = \text{hl} * (\text{TG} - \text{Tw})$

The iterative solution for **Twi** is now found by requesting **QGW** and **QFW** to be equal.

THE CALCULATION SCHEME

The first step from the top is assumed to be a “dry” step (without condensation). If **Twi** is below the gas dew point, the condensation will begin by assuming an initial **film** = .000001 (m) – if not then the dry calculation is repeated until - if- the condition is fulfilled.

Then the “wet” calculation (with condensation) is repeated until the bottom of the heat exchanger is reached (i.e. **Z = Lpass * passes**), with recalculation of film thickness and summation of condensate, pressure drops and heat removal.

Furthermore, at each step the changes in gas and water temperatures and the change in gas composition is updated.

Reporting and Files

The facilities for reporting and file handling are reached through the menu-bar File item:

OPEN option

Clicking here, You will access the Windows Explorer Browser, where You may select existing heat exchanger files, previously saved. The **default.hex** file contains the data used at GasCooler start-up

SAVE option

Clicking here, You may save the current data in a file, where You are prompted for a meaningful name. The extension *.hex will automatically be added. An example might be **Customer 070103**, which will then be saved as **Customer 070103.hex**

REPORT option

Clicking here, You will produce a printed report including design and performance data and the design sketches from the Desktop. If Your PC has **Acrobat PDF writer** installed and the printed output is directed to this program, You will produce a file similar to the file **default.pdf**, included in the GasCooler package

Installation

You begin with the GasCooler “ZIP-file” on Your Desktop

- ?? Double-click on the ZIP-file and select “Unpack all Files”
- ?? A folder named “GasCooler” will now appear on Your Desktop
- ?? Double-click on this folder and Double-click on “Package”
- ?? Now Double-click on the Setup programme and You will see the message:

Click Button to install GasCooler software to specified Destination Directory

- ?? Choose "Change Directory" and use the Windows Browser to point at the previously mentioned "GasCooler" folder at Your Desktop
- ?? Follow instructions to finish the installation
- ?? To tidy up on the Desktop, You should drag the initial ZIP-file to the GasCooler Directory and then drag "GasCooler" to e.g. "Documents"

You now may run GasCooler by Double-clicking on the executable application file called GasCooler from inside the folder or by starting the program from the Desktop button "start" (select "Programs" and then Double-click "GasCooler" in the list of executable programs.