Ingenieurbuero Samoticha
für Verfahrenstechnik

HS-SKLAD

Air and flue gas

Version 3.2

User guide

1 Table of contents

2 General information

The program serves for project of plants to the treatment of flue gases and other gas mixtures, which developed on air basis. It is the work of planning engineers within the ranges:

- chemistry,
- equipment construction,
- air condition technology and heating,
- power plant technology,
- building of furnaces,
- refuse incineration,
- environmental protection (air pollution control),
- drying process,
- within all other ranges, within which calculations with air and gas mixtures occur,

support.

With the program it is possible data to the projecting of apparatuses and processes, as well as for the enterprise of the plants in the ranges specified above to be needed to determine. After the input of the composition of the gas mixture conversions are made, e.g. from volume-% to mass-% (or reverse) damp and dry, from mg/Nm³ dry with O_2 reference to volume-% and mass-%. The program computes standard and operating density, mass flow, enthalpy and dew point (also the acid dew point in SO_3-containing flue gases). In addition physical properties are determined such as heat conductivity, viscosity and thermal capacity. The dampness is determined both absolutely and relatively. The pollutant freight interesting from the view of the air pollution control is computed.

The program computes operations at the gas mixtures. Are computed e.g. mixing with other gases, moistening, the quenching, warming up or cooling, the separation condensate water after the cooling, drying suspensions or solutions and compressing. After these operations one indicates, in which condition the gas mixture is and the data relevant for the operations will be show.

3 Description of the work surface

3.1 The main window

After the start of the program appears a work surface with the data of the last examined gas mixture. The description menu read you please in chapter 4.

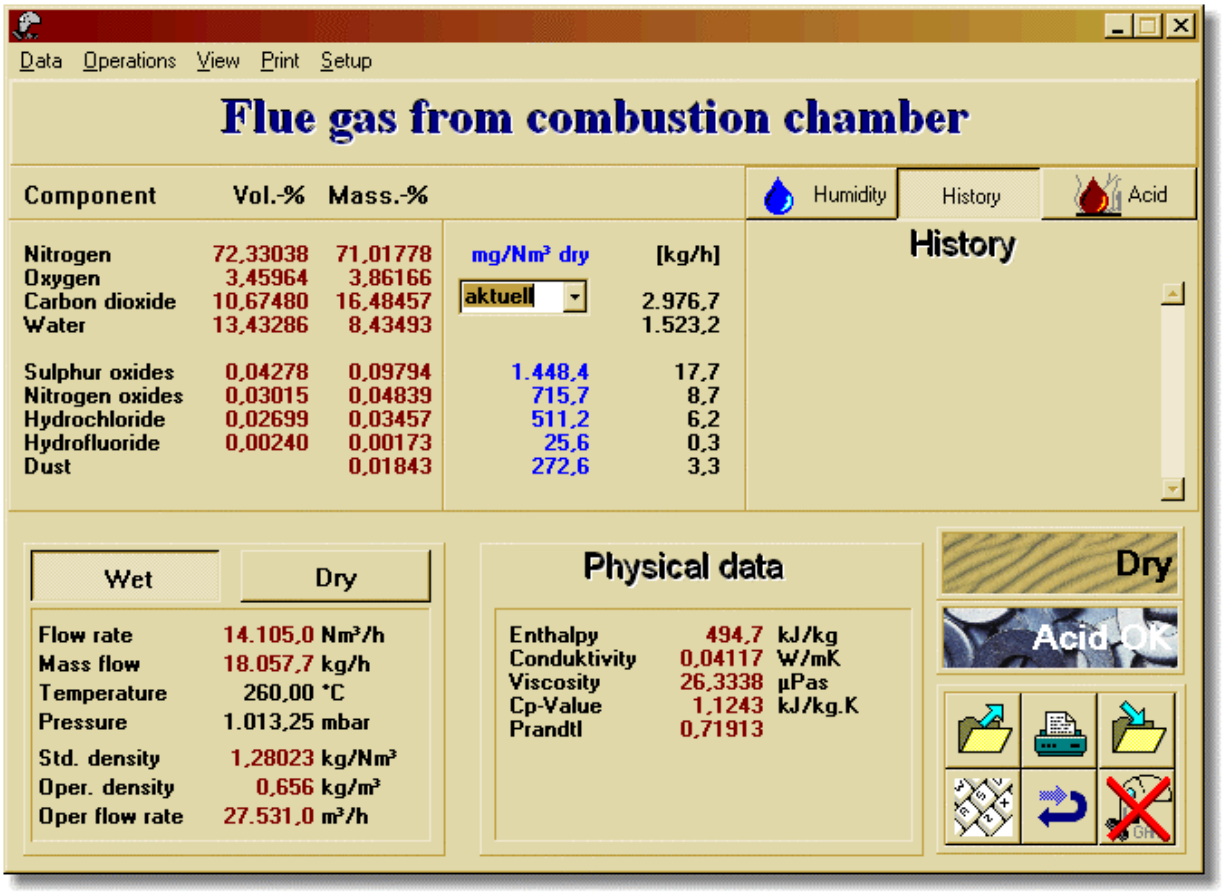


Illustration 1 The main window

In the upper left part of the sheet the composition of the gas mixture is specified in volumetric fractions and proportions (in %). As lowest component dust is listed. Dust is treated in this program starting from version 3.0 as a component of the gas mixture. Therefore it appears as component of the gas mixture and in the proportions as well as in the mass flow and enthalpy stream is considered now.

In the middle block of the upper part of the expenditure the pollutant concentrations and the freight are specified. The pollutants are indicated in milligrams per cubic meter of the dry gas mixture in the standard temperature and pressure, related to an oxygen concentration (dry). One of the possible oxygen reference concentrations is the current oxygen content of the dry gas mixture. During this attitude the concentrations of the pollutants are referred to the up-to-date available dry oxygen concentration. On the right of the column with the pollutant concentrations the freight of the pollutants and the water is listed. This freight can be only indicated, if the flow rate were entered.

In a box under the panel volumetric fractions and proportions are Buttons with the text **dry** and **wet**. If the Button **dry** is activated, all gas data, which related to the dry gas are converted and

indicated. The following philosophy was used: all data, which refer to the dry gas mixture, are blue written, and those, on the damp gas mixture refer are brown. Data with damp and dry gas mixtures equal are, are black written. After the pressure on the dry/wet key thus some data in blue appear. These are:

- volumetric fractions and mass fractions
- flow rate and mass flow
- standard density
- specific enthalpy

The concentrations of the pollutants refer in principle to the dry gas. Under the wet/dry keys (in the left lower corner) are data concerning the flow rate, the mass flow, the temperature, the pressure and the density of the gas mixture. Those well-known sizes are not marked with a question mark.

Down in the center of the form are physical data of the gas. Only with well-known temperature are visible they. The enthalpy of the gas can be computed only with well-known pressure. It is computed for the damp gas. The heat of vaporization of water in the damp gas is considered. If the indicator mode for dry gas is switched on, the enthalpy appears blue. That is the enthalpy of damp gas, related to reduce the mass of the dry gas. At temperatures between 1200 and 1500 °C these sizes are determined by extrapolation and are less exact thereby. Then they appear in grey. If the numbers do not appear, then the bounds of validity of the calculation methods are strongly over and fallen below. For closer information see chapter 6. In such a case a warning appears under the numbers.

In the right lower corner information about the corrosive characteristics of the gas is plotted. There a reference to falling below the acid dew point, the water dew point is represented or the condition of the water saturation by a picture.

In the right upper corner of the screen different information can be indicated. The choice of the announcement is made with three keys **humidity**, **history** and **acid**. The absolute dampness is indicated in [g water/kg of dry component] in the gas, relative dampness in per cent and water dew point in °C. The relative dampness can be determined only at well-known pressure and temperature, suns a question mark will appear.

The key history calls the information about the operations, which were accomplished at the gas. If the gas was submitted still of no operation, then this window is empty. The key acid with the red drop calls the information about acid dew point. The conversion rate from SO_2 to SO_3 is indicated, the concentration of SO_3 in mg/Nm³ dry with the same O_2-referenc as for the remaining pollutants, as well as (with well-known pressure) the results of the acid dew point computation according to three methods.

In the right lower corner a Toolbox is to fast calls of the frequently used functions (open file, print, save, input of data, Undo) and for terminating the program.

Hotspots

If the mouse pointer is over some numbers, it changes its form in representation of a hand. These numbers can be changed from the main window, without detour over the menu. A dialogue is opened by double clicking on these numbers, in which the numbers can be changed. This concern:

- Flow rate and mass flow (in the mode "dry" *flow rate dry*, and *mass flow dry* can be entered directly)
- Temperature
- Pressure
- operating flow rate
- absolute and relative humidity as well as dew point in the window **Humidity**
- SO_3-concentration in the window **acid dew point**.

3.2 Dialogues, help window

Actions will accomplish used dialogues. Data are mostly received, examined and if the desired action can be accomplished, the **OK** Button is released. If yet all necessary data were not entered, or some data are wrong, the **OK** Button is disabled. The text boxes, the wrong data contained are yellow emphasized. Beyond that you can let the errors list by calling the help.

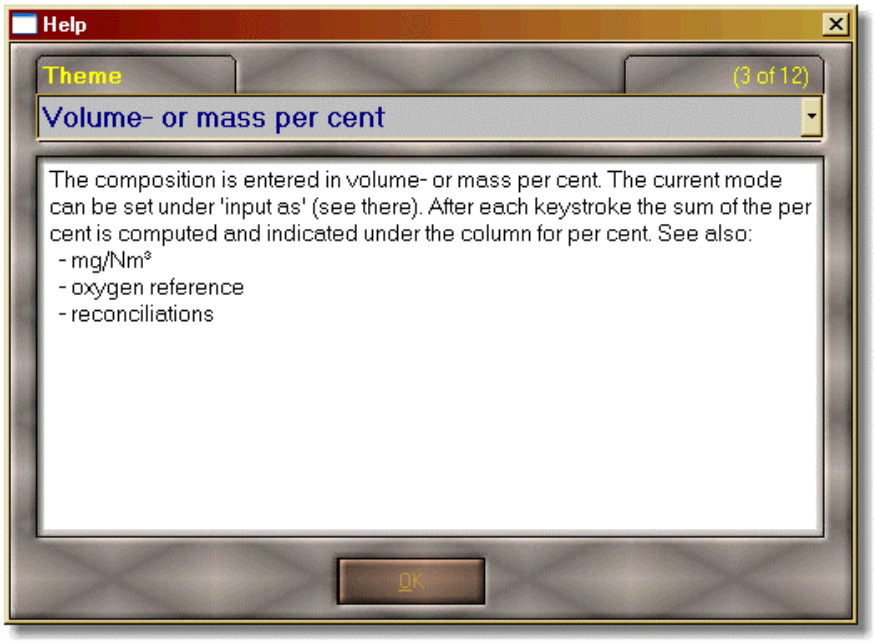


Illustration 2 The help window

The help window consists of a combo box for the selection of the topics, the white text surface, in that the explanations appear and the OK Button to closes the window. If an error were found in the input data, the explanation of the error appears, otherwise the general description of the dialogue. In the combo box you find in both cases all the topics, which are assigned to the dialogue, from which the assistance were called.

4 The Menu

The functions of the program are callable over a Pull down menu. Physically not meaningful operations and actions are disabled. Affected by it is e.g. operations at gas mixtures, whose data are incomplete, or if the gas mixture is in a condition, which does not permit the operation, e.g. a not surfeited gas mixture cannot be drained. The possibility, of quenching a satisfied gas mixture is however possible, because the experience shows that computations of such unrealistic operations are necessary nevertheless sometimes. Further no data of the not accomplished operations can be indicated or printed.

4.1 Menu Data

The menu steers the data input and output. One can enter and change the data by keyboard, load from a file or store into a file. The water content of the gas mixture can be set as relative or absolute humidity. In water-satisfied gases can drop-drug along to be defined.

4.1.1 New …

To define a gas mixture, a dialogue one will indicate, in which still no gas data are occupied. Over use dialogue read you please in chapter 4.1.2

4.1.2 Edit…

This function can be started also over the Toolbar. On the screen the dialogue window appears to the input of gas data. The data of the current represented gas appear in the appropriate text boxes. The input of the composition of the gas mixture can take place in different way. The mode of the input is set by the radio buttons under "input as...". There are the following possibilities:

With the option **Vol.-%** (pre-setting):

All gas components (not dust!) can be entered as percentages by volume. For the concentration of the pollutants additionally the possibility exists of entering it as mg/Nm³ dry. With xx volume-% dry Oxygen. After the input you must enter the oxygen reference for each component. Note: If the line of the pollutant is left, before the purchase was entered, the concentration of the pollutant is referred to the current oxygen concentration (i.e. without reference). If dust is entered, appears additional panels, in which Cp-value of dust is to be entered. Starting from the version 3 of the program dust is included into the computations of the energetic aspects. The Cp-value of dust is needed for it.

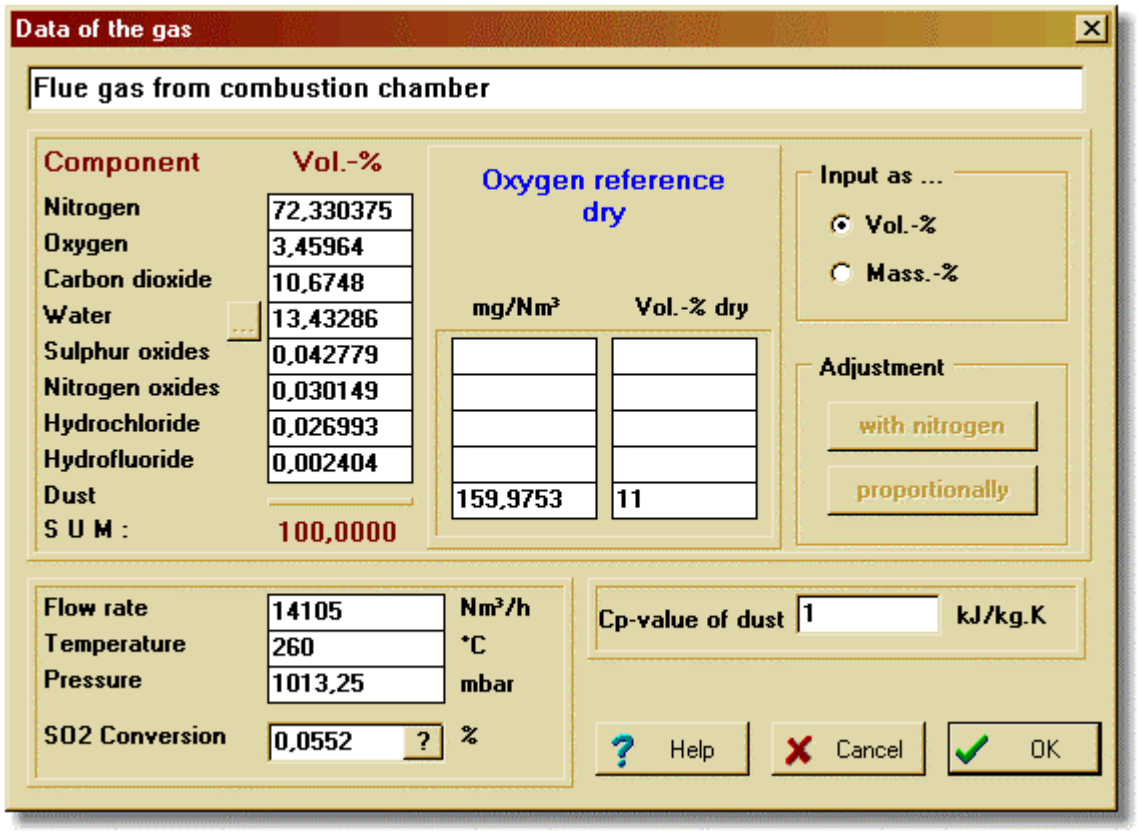


Illustration 3 Input of the gas data

With the option **Mass.-%**:

Switching on of this mode makes the columns for mg/Nm³ invisible, because the pollutants can be only entered now as mass-%.

Reconciliations

Two helpful functions are put to you during the input of the composition of the gas mixtures at the disposal. Both ensure for the fact that the sum of the inputs amounts to over Volumetric fractions or proportions 100%. That is in two ways reached. On the one hand reconciliation with nitrogen is possible (except if the deviation 'Sum-100' than the portion of nitrogen is larger), on the other hand a proportional reconciliation. A proportional reconciliation is always possible. All concentrations change.
The key with the three points in the line for water has following meaning and function: if you click on the key, the concentration of water will be fixed. It makes possible proportional reconciliation under exclusion of water. Thus the definition is facilitated by humidity content in the gas mixture.
Example: Their gas mixture is damp air with 15 volume-% water. You can enter the composition as follows.

Nitrogen 79.052 volume % (like dry air)

Oxygen 20.948 volume % (like dry air)

water 15.000 volume % (as desired)

The sum is then 115%, reconciliation is necessary. You should reach reconciliation by the following steps.

1. Click on the key beside the input box for water.
2. Click on **proportionally**

SO_3-concentration

The sulfur trioxide concentration is indicated by the conversion rate from SO_2 to SO_3. The permissible values for the conversion rate are 0 to 100%. Consider please, that from 100 mg SO_2 approx. develops for 125 mg SO_3. The conversion rate can be entered directly into the appropriate text box. In addition there is the possibility the desired SO_3-concentration without the detour over conversion rate to enter also. It exists the possibility to compute the equilibrium concentration of SO_3 from the temperature in the combustion chamber and the there dominant oxygen concentration. Click in addition to the "?"-Button in the text box for conversion. The composition of the gas mixture must have been already entered and the gas must contain sulfur oxides. The dialog window appears:

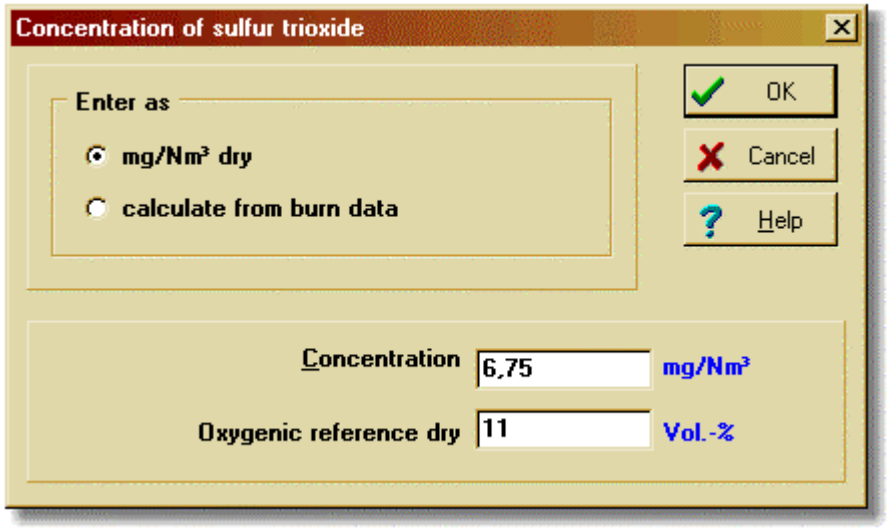


Illustration 4 Input the acidity-concentration

In the mode "mg/Nm³ dry" the concentration can be directly entered. If you select "compute from burn data", the pressure and the oxygen content must correspond to those in the combustion chamber. They are asked for "temperature end combustion chamber". Afterwards you confirm the computation with **OK**.

4.1.3 Open file…

Activate the function **Open file** from the menu **Data** or start you the function from the Toolbar. A dialogue window appears for the selection of the files. After the call, the dialogue is in the directory, made of which gas data were loaded last.

4.1.4 Dropplet carry-over

This function makes the attitude of supersaturating of the gas mixture possible through drop-drug along. Since this condition is possible with water-satisfied gases only, the gas must be satisfied, before this attitude takes place. After activating the menu option the dialogue illustrated below appears.

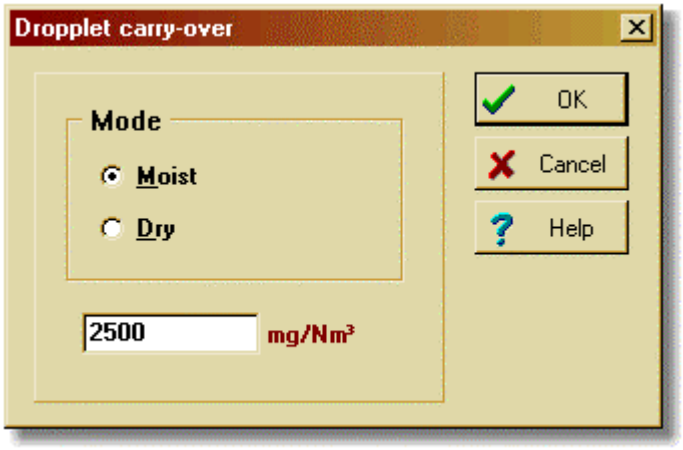


Illustration 5 Input the drop-drug along

The quantity of water is computed due to the damp or the dry flow rate. If you select the appropriate option, enter the number and confirm with **OK**.

4.1.5 Set humidity…

The water content in the gas mixture can be set with the help of this comfortable function. The program makes the following possibilities available:

- attitude of the relative dampness related to a condition defined with the temperature and the pressure.
- attitude of the absolute dampness as relationship of the mass from water to the mass of the dry component (as in the h-x Diagram)
- attitude of the water dew point, as the relative dampness of 100% is given at the desired temperature.

If you select the mode of the input, enter the desired dampness, in the mode "relatively" additionally the conditions. If you the switch "Take over temperature and pressure" switch on, the gas becomes these data.

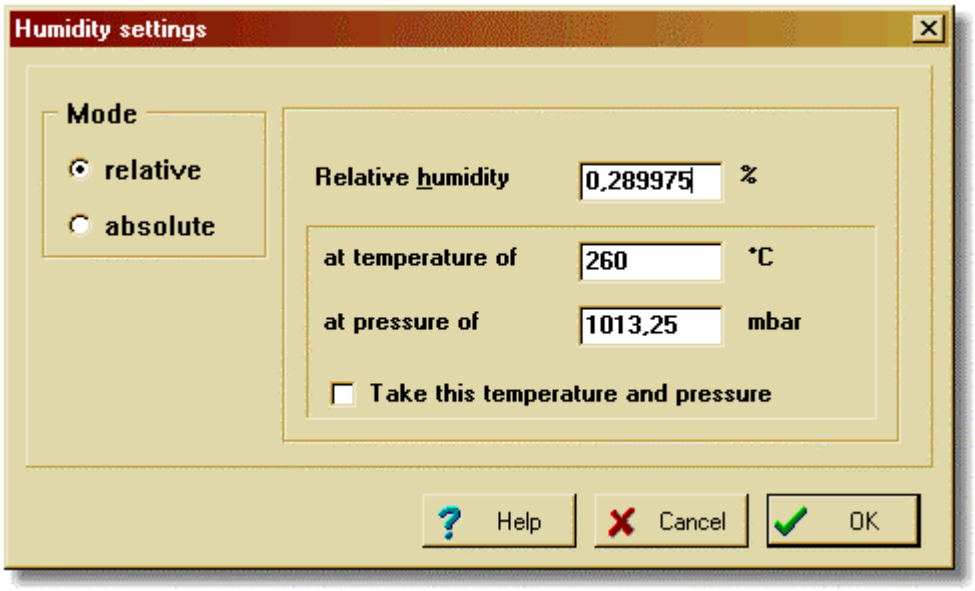


Illustration 6 Dialogue to the attitude the humidity

4.1.6 Air…

For the production of air data you can use this function. After attitude of the water content as described in the previous chapter, the composition of the gas mixture corresponds to air with defined dampness.

4.1.7 Save…

Select from the menu **Data** or from the Toolbox the function **Save**. A dialogue appears for the selection of the file. After the call, the dialogue is in the directory, made of which gas data were loaded last and which is file name the same, like that the loaded file. If no file was loaded, the name must be entered.

4.1.8 Quit HS-SKLAD

The option makes possible a leaving of the program, whereby the last gas data in the file "last-s.rgs" are stored. During the next loading procedure the data are read from this file.

4.2 Menu Operations

In order to be able to accomplish operations at a gas mixture, the program needs all gas data. Temperature, pressure and flow rate must be known. Otherwise the menu is disabled. The operation **water removal** it means a removing the fog from the gas mixture. This water removal is possible only with a surfeited gas mixture. The first two options in this menu make possible to cancel the already accomplished changes. Thus you can re-activate conditions up to 10 steps back. Single steps can be cancelled also of the Toolbox.

4.2.1 Dust

Dust is starting from version 3.0 of the program a component of the gas mixture. In the proportions, as well as in the mass flow he is considered.
The presence of dust changes however the flow rate so slightly that without the correction of the volume one did (the relation of density of <1:1000 justifies it). The energetic aspects, i.e. enthalpy stream, which are registered and separated with the dust, find with all operations attention.

Add dust.

Here a defined quantity dust can be added to the gas. Since the energetic aspects are considered, still the temperature and the Cp-value of the dust are needed.

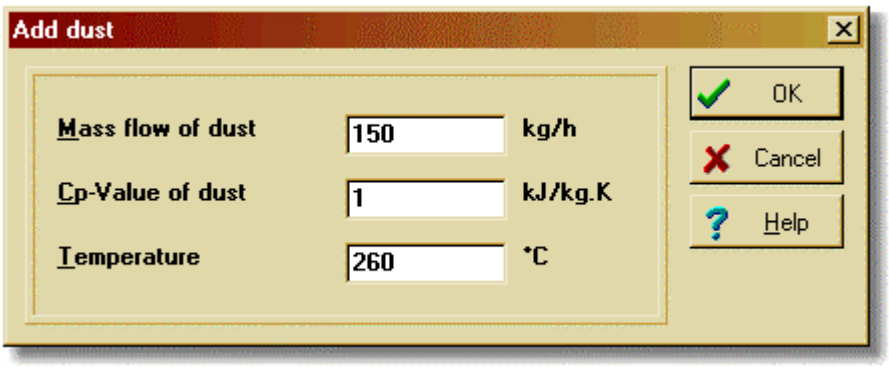


Illustration 7 Adding of dust

Data for the Cp-value of the dust as well as for the temperature are preset on current values. At the Cp-value on the thermal capacity of the already existing dust or zero. To a dust containing gas if further dust quantity is added, the Cp-value of the entire dust is averaged accordingly.

Dust removes (quantity)

Thereby can a certain quantity dust from the gas flow is removed. A simple dialogue asks which quantity is to be removed. It is preset on the entire dust freight.

Dust removes (on concentration)

If the gas in a dedusting apparatus is cleaned, the final concentration of the dust behind the apparatus is well-known, or is estimated. Here you compute the dedusting, as a defined dust loading in the gas is manufactured. The concentration refers to a oxygen concentration dry. If you do not need such a reference, use the preset value for reference. The preseted value corresponds to the current O_2 concentration.

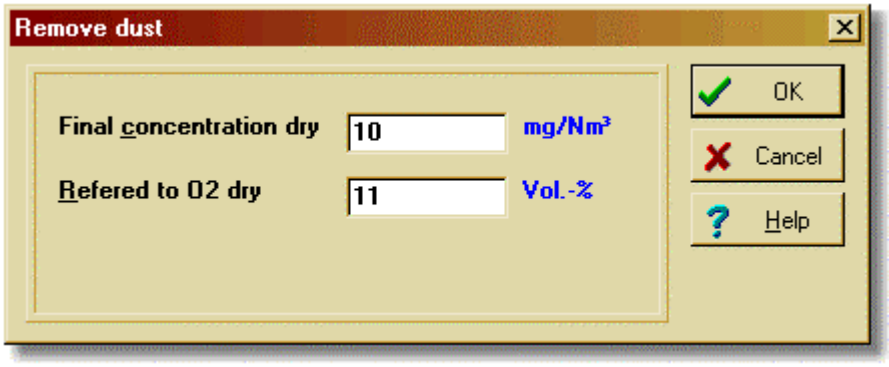


Illustration 8 Dust removal on desired residual concentration

4.2.2 Cooling/Warming

The process

In a heat exchanger warmth is supplied or extracted to the gas mixture. The composition of the gas does not change thereby. Possibly the water condensing during an under cooling of the gas under the water dew point remains contained in the gas (e.g. as nebulas, i.e. the enthalpy of the condensate corresponds the temperature given of water at). On the h-x-diagram which corresponds to operation line who runs perpendicularly upward or down from the starting condition. If the condensation is to be removed, use the operation **water removal** from the menu **operations**. The possibly condensing sulfuric acid remains containing likewise in the gas; there is also no operation that acid far away. Easily the temperature is to be changed by simply typing. The menu option makes however more possible. The final state after the rise or lowering the temperature can be defined also differently than only by the temperature. The possibilities are:

- by indication of the temperature,
- by or acceptance of enthalpy,
- by indication of the specific enthalpy,
- on desired relative dampness.

The defined condition appropriate temperature then computed and additional information will become spent.

The computation

Activate over menu **operations**, **cooling/heating** a dialogue window. Select the desired option or you leave the pre-setting "temperature".

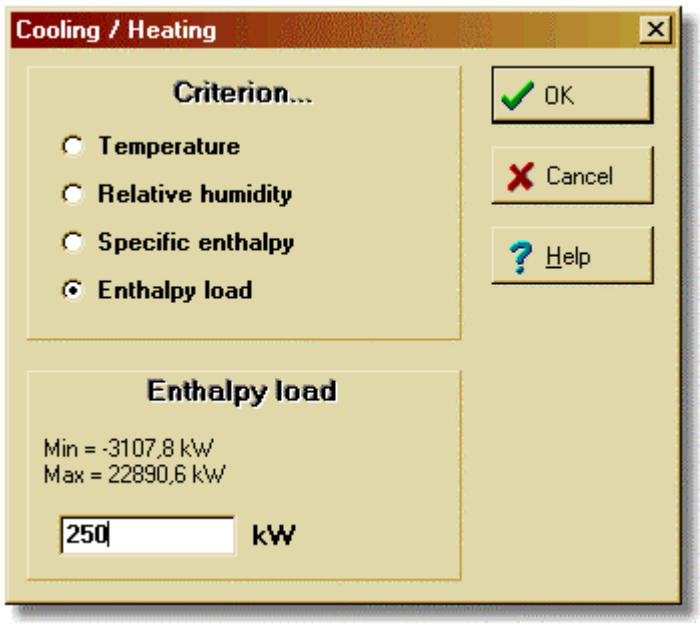


Illustration 9 Dialogue to the cooling / heating

Enter the desired number and operate the key **OK**. If the number is in the permissible range, then a computation is accomplished, the dialogue window is removed and appears a new (chapter 4.3).
At the same time the new data on the main form are represented. The new window supplies information to the process.

4.2.3 Add gas mixture

The process

A gas under the same pressure, are mixed with one another. Thus all characteristics of the gas mixture change. A new gas mixture is provided, which have the same pressure as the components.
If the pressures that differ gases from the desired final pressure (the pressure after mixing), then they are corrected before the operation (by a simple assignment of the pressure, and not by compressing). The data of the gas, which is to be added to the current gas mixture, can be loaded or typed either from a file. If desired gas in a file with the wrong or unknown pressure (or temperature) is present, the data before mixing are updated.

The computation

Select from the menu **operations** the function: **add gas**. From the popup menu, then selects you for the case the applicable option: if a file with the composition already exists, click **on gas data load**; if the data must be typed, on **enter gas data**. Accomplish open a file (see chapter 4.1.3) or a key in the data (chapter 4.1.2). Afterwards the following dialogue window appears.

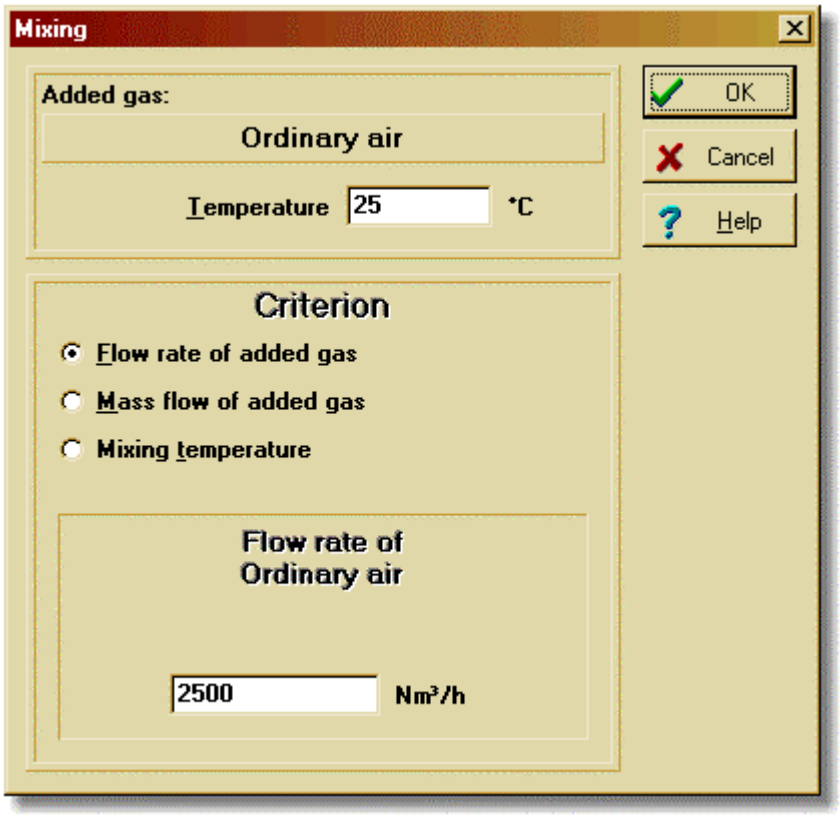


Illustration 10 Dialogue to adding gas mixtures

In the upper box the name of the gas mixture appears that to be added is. The temperature of the gas which can be added can be corrected before mixing.
Mixing can take place according to three criteria. One can enter the quantity of the gas mixture which can be added as flow rate or mass flow, or her to determine automatically let reach around a desired mixing temperature. You must naturally pay attention to the borders. The represented limit values for mixing temperature are temperatures both gases.

4.2.4 Quenching

Quenching - the process

Hot or warm gas with the temperature T_A, relative dampness ϕ_A and absolute dampness x_A steps with water with the temperature T_W into contact. The water evaporates at expense of the warmth containing in the gas. Developing steam is taken up by the gas. The temperature of the gas mixture sinks thereby on T_C and the dampness rises to ϕ_C (or x_C). With complete quenching thereby the saturation curve is reached, i.e. ϕ_C = 100%. The temperature T_C is called also cooling limit temperature. If the condition of the gas mixture reached the saturation curve, is further water absorption and thus cooling of the gas did not cause possible. The process of the operation line of this process (A - C) depends on the water temperature and resembles with T_W=0°C of an Isenthalpy.

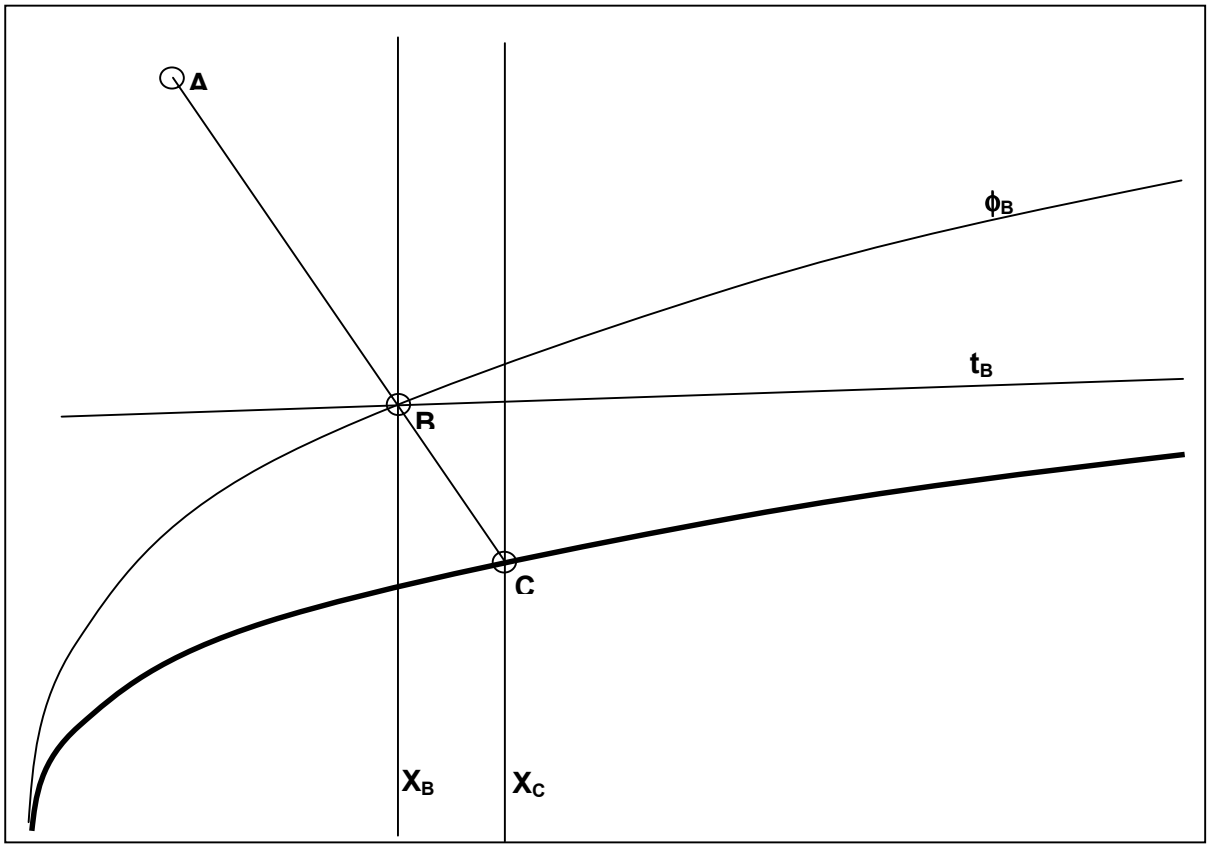


Illustration 11 Operation line of quenching

The quenching does not have to lead to the saturation of the gas with water vapour. As is the case for the enterprise of injecting coolers, the quantity of water can do those the gas is metered, to be limited, so that the condition of the gas corresponds to one point on the operation line, for which between A and C is appropriate (e.g. point B). In order to be able to accomplish the computation of a partially quenching, a size must be fixed, which describes the condition B. That can be one of the following sizes:

- the final temperature T_B
- the relative dampness ϕ_B
- the injected quantity of water

One must naturally consider the borders. Under normal conditions the temperature will lie between T_A and T_C, which correspond relative dampness between ϕ_A and to 100%, and the amount of water between 0 and the quantity of water those the evaporation up to the saturation. A "reverse quenching" of the point A the operation line along upward, is physically not possible. In the program however such a fictitious computation is possible, since it can be often interesting, to determine the gas condition which the well-known and quenched gas mixture before the Quenching had. Therefore the permissible borders of the quenching were extended:

- limit values for the final temperature are determined automatically
- relative dampness 0 - 100 %
- injected quantity of water can be able to lead negative values to take up to the complete dehydration of the gas.

In the case if the process goes from the point A "upward" it is spent, an appropriate warning.

Computation of the Quenching

Select from the menu **operations** the option **quenching**. A dialogue window appears.

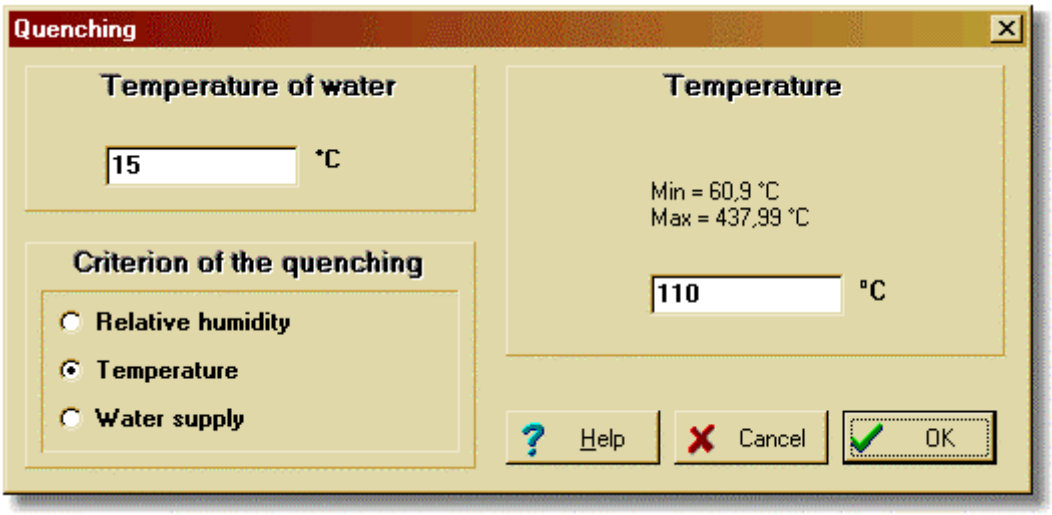


Illustration 12 Dialogue for quenching

Enter the temperature of the make-up water, choice the criterion and key in the value connected with the criterion. The pre-setting is "relative humidity". The borders are then 0% to 100%. One does not have however another criterion selected is so obvious the borders. The minimum and the maximum will be indicated. Give a value, to that within the borders lie and operate the **OK** key. Consider that the reverse quenching is possible, according to all criteria. With the reverse quenching on relative dampness of 0% the computation will stop at the critical temperature of water, so that the relative humidity 0% amounts to, but the entire water is not extracted from the gas. If you want to reverse quench on a temperature, which lies above the critical temperature of water, use the criterion "Water supply" and enter the desired negative value.

4.2.5 Suspension/ Dissolving drying

The program can compute drying processes. The process runs in such a way that the suspension/solution is taken up to gas, e.g. in spray driers. Thus also processes can be computed, with which damp powder in gas flow is entered (e.g. calcining in the hot flue gas). This process runs similarly as the quenching, with the difference that powder (dust) is taken up at the same time to the gas mixture. The energetic aspects of both processes and possible further heat effects have the program thereby to consider. Therefore also the borders are to be considered.

The dialogue expects the following data:

- portion of the dry substance in the suspension or solution.
  As relation of the mass the developing dust to the mass of the suspension/solution one understands. E.g. if a substance loses the crystal water, the portion of the anhydrite is to be indicated here. The maximum value amounts to 99.95 mass-%
- Cp-value of the solid
  It specified thermal capacity of the developing product/dust.
- temperature
  The temperature of the suspension or solution is at the entrance into the process. The temperature of the fresh suspension is to be entered.
- Enthalpy of solution
  Actually all energetic effects are to be considered here, which can develop with drying, e.g.:

- enthalpy of solution
- dehydration warmth
- cristalisation warmth
- possible other reactions

The value is positive, if during drying the warmth becomes free. It is related to the mass flow of the developing dust.

After these were entered, the program can determine the maximum mass flow of the suspension/solution. For entering the mass flow you operate the appropriate Button. The dialogue extends. Enter the number. Below the dialogue is represented after manipulation of the Buttons **mass flow**.

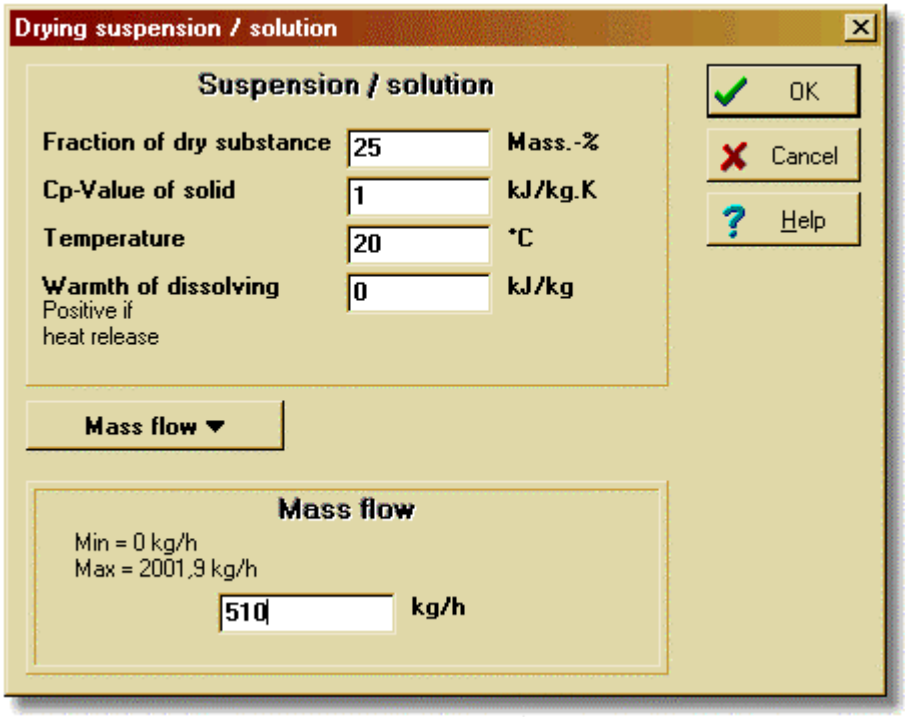


Illustration 13 Drying of suspension/solution

After the computation appears a new window with data to the process.

4.2.6 Compressing

Compressing, e.g. with conveying with blower or compressor causes a temperature rise. In this operation the temperature of the compressed gas is determined. Select from the menu **operations** the function **compressing**.

Into the dialogue window appearing then two data are given, the desired pressure and the efficiency of the compressor. Thus the efficiency of the compressing machine is alone (relationship of the actually carried out work to the achievement at the wave) meant. The more badly the efficiency, the more highly the rise in temperature - the additional achievement is converted into warmth.

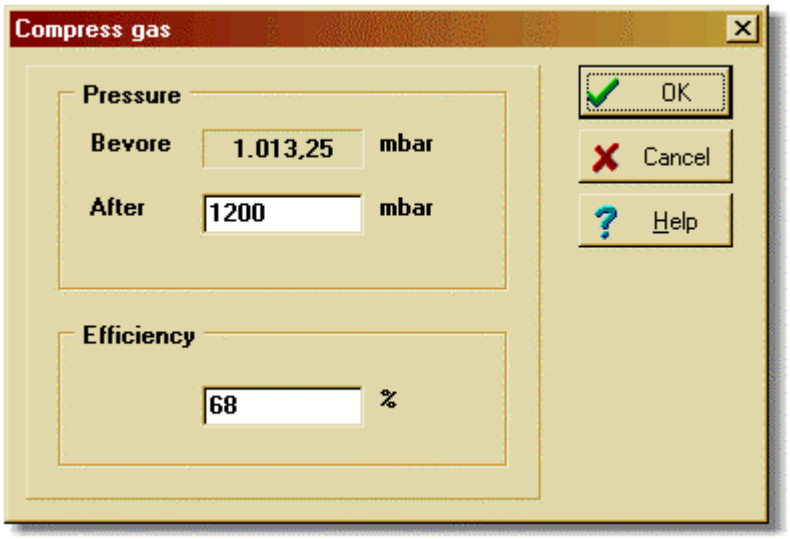


Illustration 14 Dialogue window for compressing

4.2.7 Dehydration

The operation serves for the separation a gas mixture surfeited by water from. Without temperature or pressure change as much water is extracted from the gas, which amounts to the relative humidity 100%. The gas must be surfeited before the operation, which from the symbol of a moistened surface in the right lower box of the main form is recognizable, suns is closed the operation. If a surfeited gas is present, select simply the function **Remove water** from the menu **operations**. No further information is needed. The result is represented in a dialogue window (see chapter 4.3).

4.3 Menu Show

Those already at the current gas accomplished operations leave a trace in the program. The data of the operation are stored and are available until the operation is repeated. There is always the data of the last quenching, compression etc. available. Those can be called with the help of this menu. The same dialogue window is opened, which appeared to the operation during accomplishing. You can also print the data of the operation from here. For last mixing no window is intended, the data of this operation is stored, but not displayable. You can print it (see chapter 4.4).

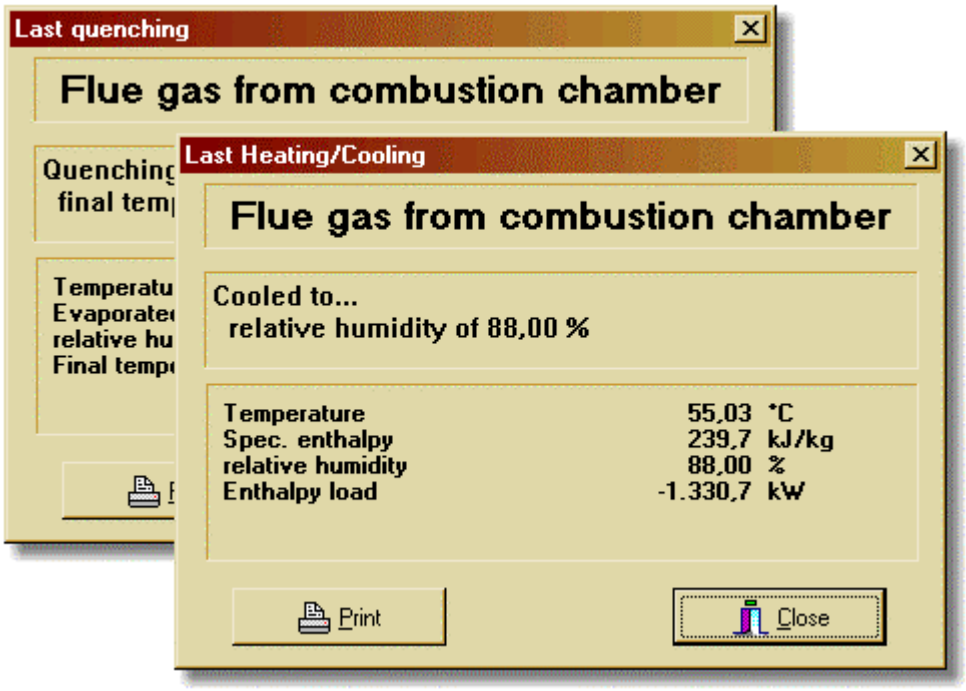


Illustration 15 Results of the operations

4.4 Menu Print

To those in this menu available functions it applies in principle same as to the menu **Show**, only that the output takes place not on the screen, but on the printer. This menu contains two options more:

- last mixing (mixing cannot be shown on the screen)
- current gas data
- Dialogue

The data of the accomplished operations, or all data of the current gas indicated on the screen is printed.

Print current gas data

All available data of the current gas are printed out. The print consists of the following parts:

- headlines: Here the name of the gas mixture is indicated
- table with the composition and the parameters, that for wet and dry are different
- table with pressure, temperature and resulting physical properties
- table with data concerning the humidity content
- table with data concerning acidity
- case applicable, box with history of the gas (operations)
- indication of the oxygen reference for the pollutant concentrations.

The reference oxygen concentration corresponds to that, which was adjusted on the screen before printing. If you want to print e.g. the concentration of the pollutants, related to 11 volume-% oxygen dry, set the reference concentration of 11 % on the screen and then print.

Dialogue

You become here an overview of the available information and select the sides, which are to be printed. In addition the dialogue offers the selection of the printer as well as the possibility to setup printer.

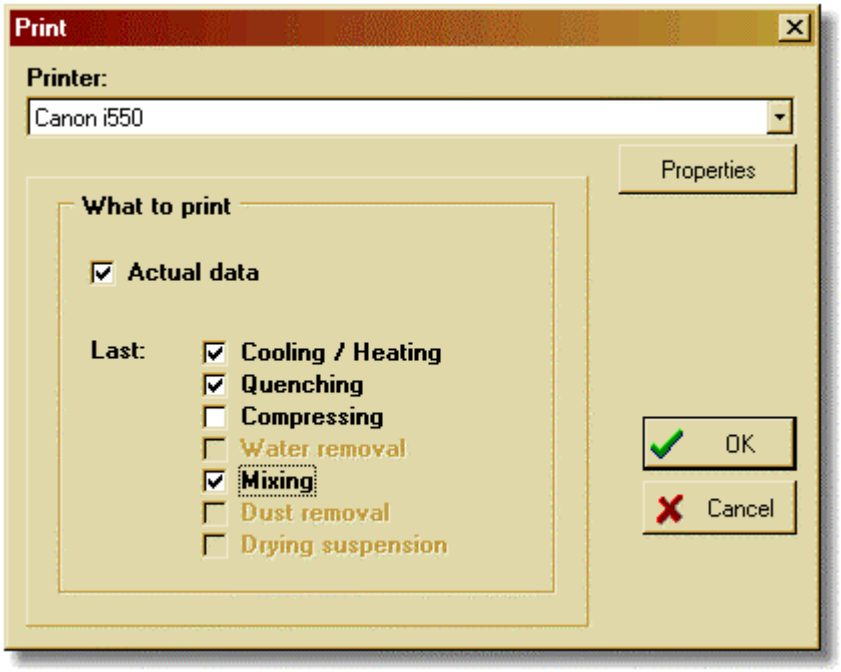


Illustration 16 Dialogue for printing

4.5 Menu Info

Those in this menu available function make the attitude of the Dongles possible and spend information about the program.

4.5.1 Setup Dongle

The user does not need to make the attitudes of the Dongle.

4.5.2 International

Here you can select the language and the system of units. Please read more details over the use in the chapter 5 "Units system".

4.5.3 About HS-SKLAD

Here you get the information about the version of the program, as well as the contacts of our engineer's office.

5 Units system

This program enables working in the units of international SI system of measure, and also in the alternative, optionally defined by the user, system of units. It is possible to switch between these systems during work.

C A U T I O N !

The alternative system of measure units is defined by the user, therefore:

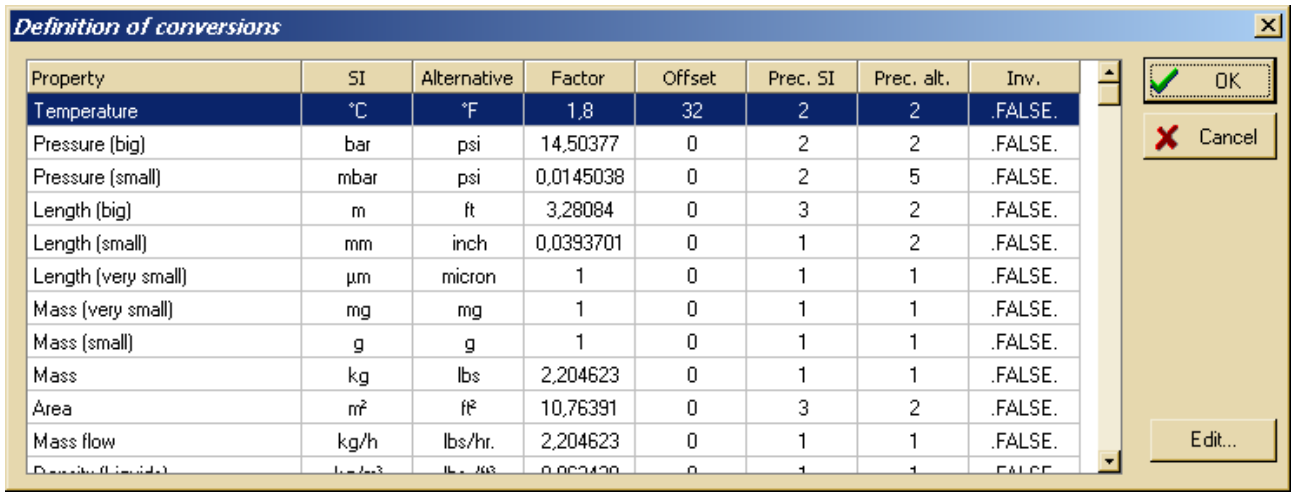
the user himself is responsible for the correctness of the recalculation definitions!

This refers also to the optional conversions already included in the newly installed programs. The user is obliged to check its correctness, before he starts using it!

Especially, the standard gas condition may be differently defined, therefore it recalculates into the standard in the SI system (0°C, sea level) can be different.

The recalculation definitions are used together by all the programs. The changes are made as follows:

Hit menu **Setup/International…** and generate the settings dialogue. Here the units system can be chosen. The changes are made after pressing **Edit…** button. Then, the window with the defined recalculations table appears:



Property	SI	Alternative	Factor	Offset	Prec. SI	Prec. alt.	Inv.
Temperature	°C	°F	1,8	32	2	2	.FALSE.
Pressure (big)	bar	psi	14,50377	0	2	2	.FALSE.
Pressure (small)	mbar	psi	0,0145038	0	2	5	.FALSE.
Length (big)	m	ft	3,28084	0	3	2	.FALSE.
Length (small)	mm	inch	0,0393701	0	1	2	.FALSE.
Length (very small)	µm	micron	1	0	1	1	.FALSE.
Mass (very small)	mg	mg	1	0	1	1	.FALSE.
Mass (small)	g	g	1	0	1	1	.FALSE.
Mass	kg	lbs	2,204623	0	1	1	.FALSE.
Area	m²	ft²	10,76391	0	3	2	.FALSE.
Mass flow	kg/h	lbs/hr.	2,204623	0	1	1	.FALSE.

Illustration 17 List of units recalculations

After marking the row and using the button **Edit...** the selected recalculation can be edited.

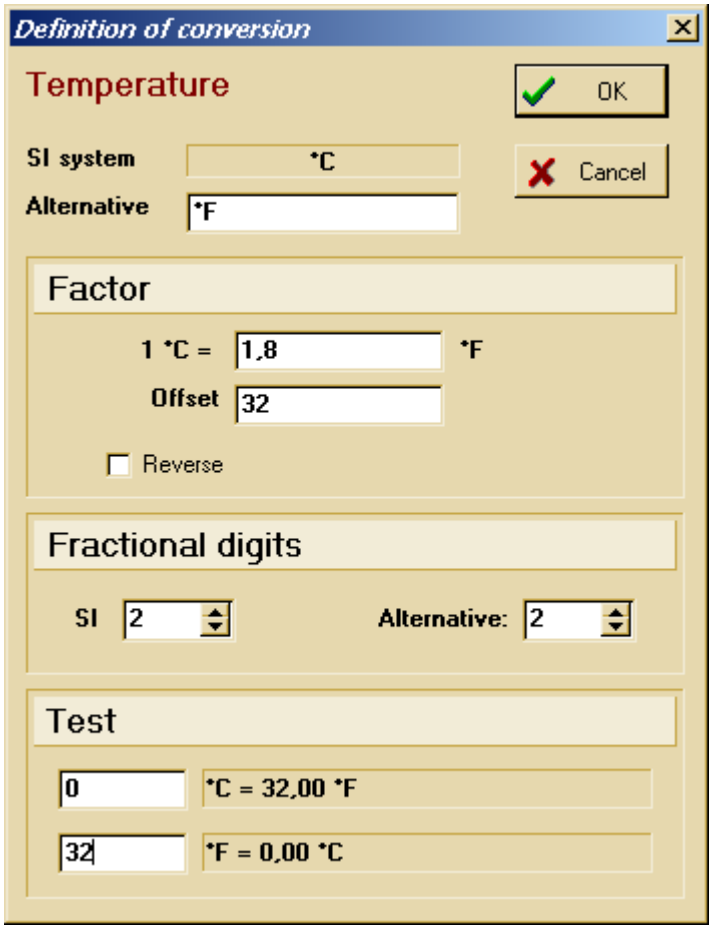


Illustration 18 Defining the recalculation

This example illustrates the definitions of temperature recalculations between "°C" and "°F". At the bottom of the dialogue, there can be tested the correctness of the entered data and set the number of digits after comma.

6 Calculation methods and characteristics

6.1 Validity bounds of the variables:

Flow rate:	The valid values are numbers to 9.999.999 Nm³/h
Temperature:	-90 to +3500°C for enthalpy
	-20°C to 1200°C for the physical characteristics
	Quenching of a gas under +20°C is blocked. At temperatures below 0°C is to be counted on a reduction of the accuracy computed physical properties.
Pressure:	50 mbar to 8 bar
Water content:	0 to 30 mass-%. Outside of this border physical dimension no more are computed with the accuracy indicated below.

CO_2-content: 0 to 20 mass.-%. Outside of this border physical dimension no more are computed with the accuracy indicated below.

6.2 Nomenclature

By nitrogen in this program "atmospheric nitrogen" is understood, i.e. than nitrogen with the mixing of CO_2 and noble gases, usual for air. The composition is then as follows:

nitrogen 98.775 vol.-%

argon 1.182 vol-%

neon 0.003 vol-%

carbon dioxide 0.040 vol-%

The standard amounts to then 1.2570 kg/Nm³.

Dry air has the following composition when this agreement:

Atmospheric nitrogen 79.052 vol-%

oxygen 20.948 vol-%

By sulfur dioxide both SO_2 and SO_3 are understood. The concentration of the two oxides is regarded in the program as "sulfur oxides as SO_2". The information about conversion rate gives the basis for the computation of the SO_3 concentration.

Under nitrogen oxides NO_2 and NO are understood as "nitrogen oxides as NO_2"

6.3 Accuracies:

The program discuss gas mixtures on the air basis developed. To such gas mixtures the accuracies specified down apply.

The polynomials, which were used for the computation of the material data, to have a range of validity of:

temperature	0	to	1200	°C
water content	0	to	30	mass-%
CO_2 content	0	to	20	mass-%

With gas data, which in these borders the following accuracy will be reached:

for thermal capacity	$\varepsilon_C < 0{,}15$ %
for viscosity	$\varepsilon_V < 0{,}90$ %
for Prandtl	$\varepsilon_P < 0{,}55$ %
for heat conductivity	$\varepsilon_\lambda < 1{,}08$ %

For the enthalpy a calculation method was used, whose validity extends up to 3500°C. Even if the program announces the exceeding of the validity bounds for physical properties, exact computations of the enthalpy are guaranteed.

7 License agreement

Application range

This program can be used on the optional amount of computers within the company. Installation in the networks and the simultaneous installation on many computers of this company is allowed. The amount of simultaneously used licenses is regulated by the purchase of dongles or the hire contracts made.

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