A method for calculating the design of flanges- Part 2

Flange connection designers are confronted with a growing number of standards, regulations, and templates which they must take into account in their work. The main difficulty being the necessity to adopt calculation coefficients for gaskets when calculating assembly and operating tension valves. No one method is universal. Last month Valve World printed the first part of a paper by Europartner detailing a new software program that can calculate any gasket defined by the user, hereby considerably reducing the complicities of this design procedure. What follows is the second instalment.

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STEP 3
Flange selection geometry
Number of flange types in the database – 104.

Depending on the running calculation standard, the program makes standard-relevant flange types available for selection and calculation. The user first determines a general flange type, e.g., fixed, loose, and then within this choice, determines the specific flange type. All dimensional fields which, from the point of view of conducted calculations, belong to the selected type are fully editable. If the user wants to select a flange of normative dimensions for calculations, he can use the flange dimensions recorded in the database. For such selection a special tab is used, where it may be chosen according to which standard the flange is to be designed, e.g., PN, EN, DIN, what is going to be its DN and PN. After clicking the *Convert dimensions for calculation* button the program transfers normative geometry dimensions to the calculation section of the selected standard. These dimensions can still be changed, however.
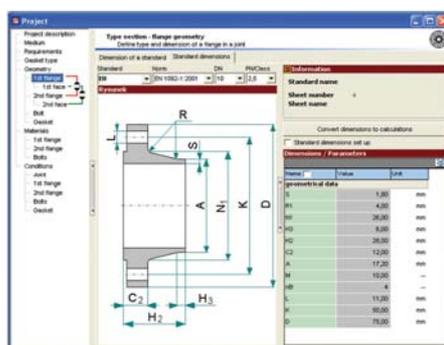
STEP 4
Face surface selection geometry
Number of face types in the database – 11.

It is assumed that each type of face can be fitted to the face surface (turned on it). Thus the necessity to specify the face type in the program. This is done in the *Face* sections. There is, of course, the possibility, just as in case of flange selection, to select faces of normative dimensions from various standards. The program does not limit the designer when a necessity of such dimensions change occurs and it monitors the conformity of flange and face PN and DN.
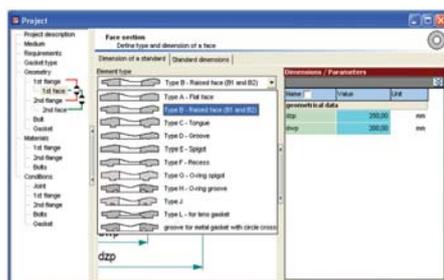
STEP 5
Bolt selection
Number of bolt types in the database – 6. Correct selection of bolts, their size, number and material significantly affects the possibility of the gasket forming and its operation. For example: too small a number of weak bolts may not guarantee correct gasket forming. The program allows for the modification of all bolt-related quantities so as to obtain, as a result, appropriate assembly and operational tensions, at minimal number and size of bolts. Not to mention a reasonable material selection from the strength conditions viewpoint.

The results can be viewed on the program result template in the form of dynamically changing results for particular gasket types. The *Dimensions* tab gives the possibility to determine the normative geometry of screws. Transfer of these dimensions from the normative model to the calculation model is done according to the above mentioned rules. Depending on selected calculation standard, additional editable fields connected, for example, with the method of bolts tightening or with assumed friction coefficient on the bolt thread and head, appear in the screw section.
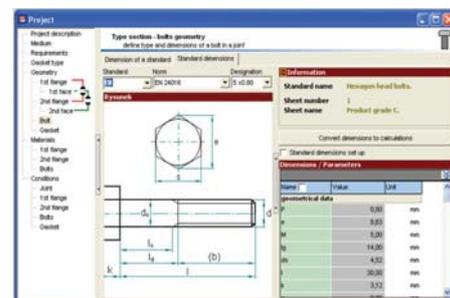
STEP 6
Gasket type and geometry selection
Number of gasket dimensional standards in the database – 30.

The gasket type is automatically selected by the program on the basis of the following information: medium (type, concentration, maximum pressure and temperature), special requirements and face types. A list of gaskets which can work in the defined conditions is generated, but the final decision concerning the gasket selection belongs to the designer. Specific choice results in current calculation of all quantities, and so the user can instantly see how his choice influences final quantities. Selection of particular seal type is not limited only to gaskets cut from a plate, but also to complete sealing constructions.

In the selection section the user has the choice from among soft-material, metal, spiral or metal-jacketed gaskets. After taking into account the user's choice the program shows information about seal construction and materials.

The program possesses a very large database of gasket normative dimensions according to various standards. The designer selects a specific gasket according to PN and DN values (or NPS and Class). When the specific geometrical dimensions of a gasket have been chosen, automatic control of matching the geometry and face surface dimensions takes place. Possible errors are signalled with detailed information displayed in the error detection window.


STEP 7
Selection of joint component materials
Number of materials entered in the database – 598.

The program possesses a very large database of material information and their strength quantities, such as Rm, Re, R0.2, E, A5. These quantities are given for various temperatures and depending on available information sources. Displayed information are, however, only of informational and auxiliary character. In the part concerning determination of operation parameters for particular operation states, the designer can enter his own values of these parameters. Steel materials are grouped in sections describing their type, e.g., steel resistant to corrosion. Other sections: material name, thickness range and steel component type. The designer has to decide which strength parameter is to be used for calculations. Searching for appropriate material takes place through definition of group assignment or its specific name or Werkstoff number. Depending on flange type, independent selection of materials for all its components is available, so for example: flange, collar and shell materials. Bolt material is selected in a similar way.

STEP 8
Definition of operating conditions
Number of operating conditions possible to be defined – 10.

Operation model of the flange connection in EN 1591 assumes, in accordance with the New Approach Directives, the necessity to conduct calculations in all these operating conditions in which the risk of emergency running of pressure equipment can occur. The designer determines the number of operating conditions which have to be calculated. The software allows to define additional operating conditions and specify in details their parameters, such as temperature, pressure or safety factors. When a new operating condition has been defined, the program automatically calculates all conditions and adds a relevant tab in the result section.

The rule of defining operating conditions has also been transferred to other standards in which, up till now, only the operating condition was defined.
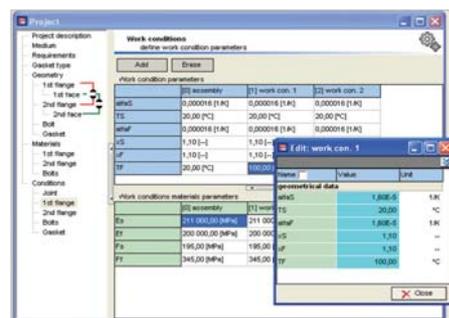
STEP 9
Results of selection and calculations
Regardless of the algorithm used in calculations, the following information is obtained on the result panel as a result of the program operation:

– name and thickness of the gasket, its geometrical dimensions, active dimensions included,

– values of assembly and operational tensions for the selected seal,
– values of forces in screws and in an individual screw for all conditions,
– values of the nut tightening torque,
– values of tensions in gasket, bolt and flange in comparison with relevant permissible values,
– additional information connected with conducted calculations (e.g., percent value of screw material use).

All mentioned information change dynamically during any change of input data values. Thus, the designer may control calculation results all the time and can easily change input data (e.g., screw material).

STEP 10
Print
Each of the algorithms, which the program is equipped with, generates complete printouts. It means that page headlines, design descriptions, full input data, intermediate results and final results together with formulas are created. Additionally, at the user's request it is possible to attach the comments which have been added to any section of the program to the print. The program has a special tool to support prints, and so, results in the form of prints which were earlier saved on the disk can be