Advanced Services

amtec

Monitoring of Relevant Loads, Gasket

TIGHTNESS &

Testing, Test Rigs for Gaskets, Calculation

INTEGRITY OF

of Flanged Joints, Tools for Assembly,

FLANGED

Monitoring of Fugitive Emissions,

JOINTS

Joint Integrity Management System

amtec

Advanced Tools and Comprehensive Services for
the Reduction of Fugitive Emissions

Function of Tightening Joints

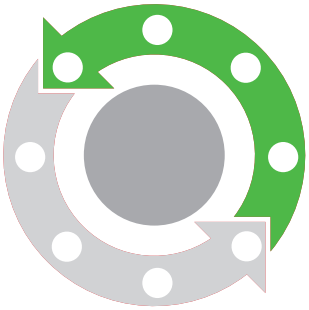
In chemical and petrochemical plants as well as in other parts of industry, bolted flanged joints still are necessary for many purposes. With increasing demands, both economically and ecologically, a correct function of these flanged joints is necessary. Correct function of a flanged joint is given if it is tight and its integrity is guaranteed for the entire period of operation.

TIGHTNESS & INTEGRITY

Integrity usually is achieved by limiting the stresses in the components. Tightness means, the emissions of the joint are limited. The limit, a tightness class depending on the medium that has to be enclosed, is given by legislation or by the licensing authorities.

The best way to achieve function is a consequent analysis of the bolted flanged joint:

- the relevant loads during assembly and in operation have to be known,
- the design of the joint as well as of the gasket must meet the demands,
- the necessary gasket factors have to be determined,
- the assembly bolt (pre)stress value has to be determined,
- stress and tightness analysis have to be performed,
- the mounting procedure has to be reliable and related to the demands.



ECOLOGIC & ECONOMIC TASK: MINIMIZE EMISSIONS

This analysis should be performed preventively and iteratively, if necessary, to reach the optimum requirements. Thus the cost of repair and of forced outages as well as the effort for control of the emissions can be reduced to a minimum.

amtec offers comprehensive tools and advanced services for every aspect of this analysis:

- monitoring of the real loads,
- selection of the most effective gasket,
- evaluation of gasket characteristics (gasket factors),
- software and services regarding calculation of flanged joints,
- tools for controlled assembly and tightening of joints,
- database tools for joint integrity management systems.

amtec plays an active role in national and international research projects. Its staff is working steadily on the field of codes and standards and has many years of field experience regarding bolted flanged joints.

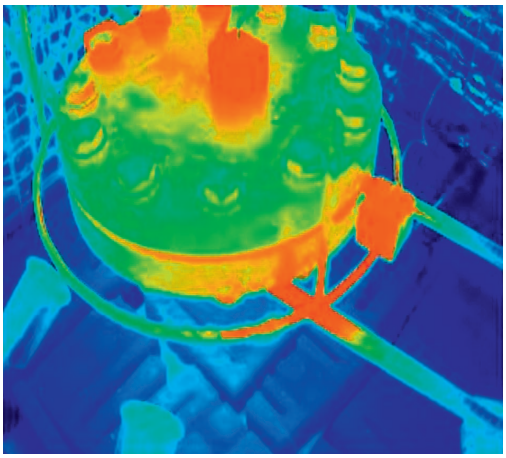
Loads

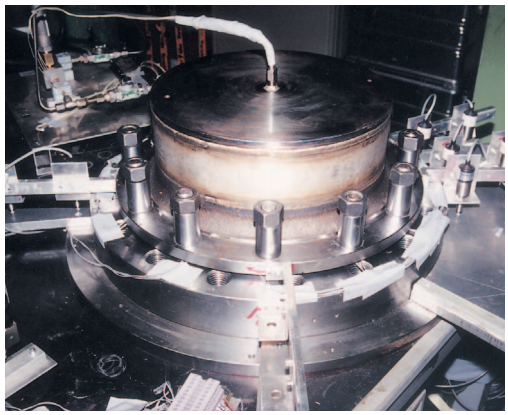
In operation, a tightening joint is loaded by internal pressure and temperature for example and, more relevant to the joint's function, with transients of these parameters. In piping systems there may be "external" forces and moments, resulting from thermal constraints or from mounting conditions, e.g. mismatch of the flanges or angle between the two flange faces. These forces can lead to a relevant additional loading or unloading of the gasket. If the analysis has to be reliable, every load parameter must be known or verified.

The relevant loads are input data both during design of the joints and for tightness as well as for stress analysis. Consequently, the accuracy of these data is very important for the reliability of every assessment. In a lot of cases, the real loads can only be determined by monitoring.

MONITORING
STATIC / DYNAMIC

Therefore, **amtec** monitors the load transients on site, if necessary. There is a variety of transducers and measurement systems for static and dynamic measurements on stock.





Gaskets

The selection of a suitable gasket is perhaps the most important task regarding the function of a flanged joint. The first parameter that has to be taken into account is the long term stability under operating conditions. Medium, temperature, loads and the expected time of operation are major points to consider.

The necessary gasket factors for a detailed stress and tightness analysis depend on design details: the gasket can be floating between the flange faces or the flange platens have metal-to-metal contact. Flanges with metal-to-metal contact are found in valves mainly, whereas flanges in piping systems and in pressure vessels are of the first type.

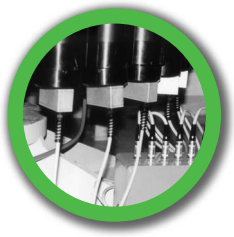
Regarding flanged joints with the gasket between the flange platens, the tightness class or leak rate is determined by a good seating of the gasket during the mounting procedure and by an application of a sufficient minimum gasket stress in every relevant state of operation. Additionally, the maximum allowable gasket stress values are important. They characterize or limit the deformation behavior of the gasket, together with the elastic recovery.

LONG TERM STABILITY
DEFORMATION BEHAVIOR
TIGHTENING CHARACTERISTICS

Regarding flanged joints with metal-to-metal contact of the flange platens it is necessary to reach contact and then to maintain sufficient contact stress in every relevant state of operation. The gasket stress which is necessary to reach contact determines the maximum internal pressure for a given leak rate of the joint and can only be reduced by relaxation of the gasket stress under operation temperature.

amtec provides engineering services especially for the correct choice of the design and of the gasket. **amtec** has developed test rigs for every relevant gasket factor, e.g. testing according ASTM and PVRC methods, EN 13555 or DIN 28090. Thus it is possible to determine every necessary gasket factor for the selection of the gasket and for an analysis of the joint.

1 Mechanical Press
2 Leak Rate Measurement Equipment (Pressure Decay)
3 Computer and Monitor
4 Control Unit
5 Leak Rate Measurement Equipment (Helium Leak Detector)
6 Cooling Device
7 Hydraulic Pump



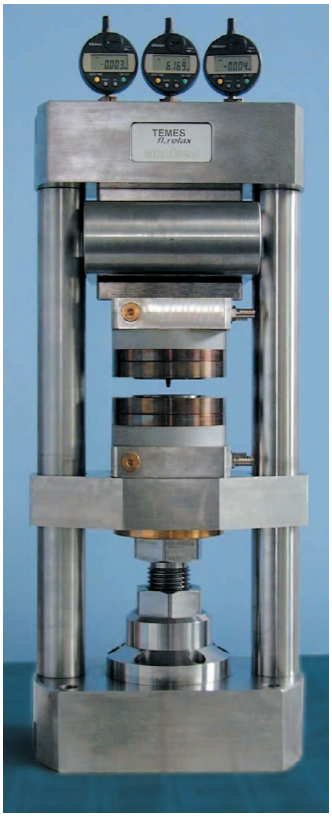
Gasket Characteristics

For the determination of relevant gasket factors as defined in standards it is necessary to perform

- compression tests,
- compression creep tests,
- creep relaxation tests, and
- leakage tests.

Regarding the compression tests and the leakage tests, the same loading device (servo-hydraulic-press **TEMES** *fl.ai1*, capable up to a load of 1,000 kN (225,000 lbf)) is used.

Gaskets up to 165 mm (6.5 inches) in diameter can be tested in **TEMES** *fl.ai1*. The design of the test rig is modular, so it can easily be modified to different types of tests, (e.g. heating platens for temperatures up to 400 °C (750 °F), different flange face designs or leakage etc.).



Regarding the leakage measurement several options are available:

- the pressure decay method,
- the pressure increase method,
- a mass spectrometer.

TEST RIGS FOR GASKET FACTORS

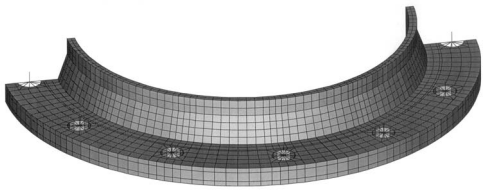
All tests can be performed manually, but, as the tests are time consuming, the possibility to perform software-controlled tests has major advantages.

In principle the creep and relaxation tests can be performed in the servo-hydraulic press **TEMES** *fl.ai1*, too. However, as there are a lot of parameters affecting creep and relaxation, a lot of long-term tests are necessary. Thus it is more convenient to use several simple mechanical test rigs.

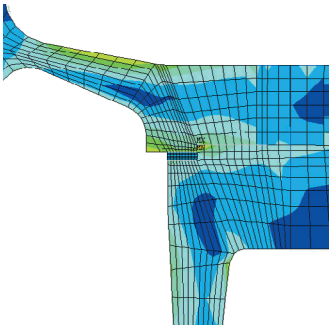
The **TEMES** *fl.relax* test rig consists of two platens with high stiffness, between these platens the gasket is compressed. It is possible to heat the platens up to 400 °C (750 °F). The device is loaded mechanically using a nut (maximum load 300 kN (67,000 lbf)), the maximum gasket diameter is 100 mm (4 inches). Different stiffness of real flanges can be simulated.

Calculation

The first task of a calculation is to determine the **assembly stress** level of the joint. An assembly stress value is necessary for every flanged joint, therefore, this part of the calculation has to be done in each case. The second task of a calculation is a **stress analysis** (prevent destruction). If there are cyclic loads, a fatigue analysis has to be performed, too. Finally, the third task is a **tightness analysis** (to control emissions, i.e. to maintain a demanded tightness class).



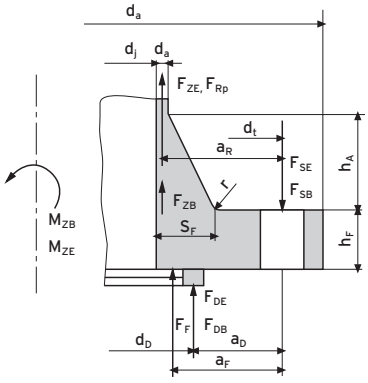
For reliable calculation results it is necessary that all parts of the assembly (i.e. flanges, bolts and gasket) and their interaction are regarded.



Any calculation has to

- regard realistic operation conditions like internal pressure, external forces and moments, temperature, temperature distributions, deformations etc.,
- regard stiffness of flanges, bolts and gasket,
- use relevant and realistic gasket factors,
- determine the necessary gasket stress level for assembly, and
- determine gasket stress in each operation state.

amtec offers calculations for flanged joints either analytically (ASME, CEN, DIN) or detailed analysis using Finite Element Analysis (FEA). Both flanged joints with the gasket floating between the flange platens and flanged joints with metal-to-metal contact of the flange platens can be analyzed. The flange calculation software **TEMES** *fl.cal* (calculation according EN 1591 and other standards) is available in German, English and French language.



CALCULATIONS ACCORDING TO ASME, CEN, DIN &
CALCULATIONS USING THE FINITE ELEMENT ANALYSIS (FEA)
STRESS ANALYSIS
FATIGUE ANALYSIS
TIGHTNESS ANALYSIS

Assembly and Tightening

The mounting procedure is another essential step that is important for the correct function of bolted flanged joints. During mounting the given assembly stress value (tightening torque) has to be applied. The tightening procedure has to meet the demands on the function: tools range from hammer wrench to explicit control of the applied forces.

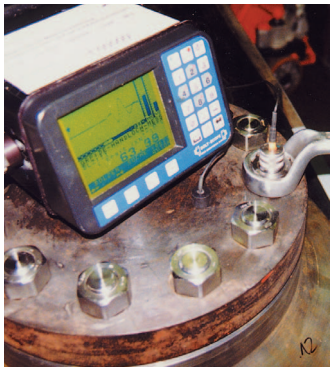
If the demands are stringent, e.g. regarding flanged joints in systems with dangerous or poisonous media, the use of hydraulic spanners may be a good choice. **amtec** provides **TEMES** *fl.ctrl*: hydraulic tensioners of all sizes for an effective tightening of bolted flanged joints.

Additionally, control of successful tightening may be necessary. In this case, there are tools like bolt elongation measurement or ultrasonic bolt stress measurement methods, for example. Detailed control is provided using **amtec** **TEMES** *okto.ms* products.

The assembly procedure inclusive disassembly must be regarded as an important step in quality control of the joint. This can only be performed if the flanged joint assemblers are qualified. Experience made during disassembly and assembly has to be fed back into the analysis of the joint.

HYDRAULIC TIGHTENING
ALL BOLTS ARE LOADED SIMULTANEOUSLY
UNIFORM DISTRIBUTION OF THE LOAD

CONTROL OF ASSEMBLY STRESS
ABSOLUTE VALUE AND
SCATTERING DOCUMENTATION



amtec performs emission measurements as demanded in several national and international regulations. This can be done on site, e.g. according EPA 21, or in specific tests in our labs.

CHECK OF EMISSIONS ACCORDING TO EPA 21 OR VDI IN OUR LABS OR ON SITE

Monitoring of Emissions

amtec has many years of field experience regarding bolted flanged joints. On this base, **amtec** is following an integral philosophy to realize reliable function of flanged joints. Competent consulting is one of our services.

Consulting, Training

Training can be provided in our labs as well as directly on site. Visit our website for actual dates of training courses and workshops.

PROTECT ENVIRONMENT

MINIMIZE EMISSIONS

quality certified ISO 9001

amtec *provides advanced tools and services for:*

- *gasketed flanged joints*
- *stuffing box packings*
- *valve integrity*
- *integrity analysis of piping systems and vessels*

amtec Services GmbH

Hoher Steg 13
74348 Lauffen/N.
Germany

phone +49 7133 9502-0
fax +49 7133 9502-22

info@amtec.eu
www.amtec.eu