Software and Services



ASME, CEN, DIN, FEA,

**CALCULATION** Stress Analysis, Fatigue Analysis,

OF FLANGED

Tightness Analysis

JOINTS





Advanced Tools and Comprehensive Services for the Reduction of Fugitive Emissions



# Demands on

## **Tightening Joints**

Environmental legislation and regulations have become more stringent

in recent years. "Best available technology" is demanded to minimize emissions. On this background the demands on correct function of flanged joints have been

PROTECT ENVIRONMENT

specified in greater details in all parts of industry.

Correct function of a flanged joint is given if it is

tight and its integrity is guaranteed for the entire period of operation. Integrity usually is achieved by limiting the stresses in the components (safety against failure). Tightness means, the emissions of the joint are limited.

MINIMIZE EMISSIONS



#### **RELIABLE PROCEDURE: CHECK EVERY POSSIBLE PARAMETER**

According to the amtec philosophy the "best available technology" to minimize emissions is to apply an integral procedure, similar to a quality improvement circle. The analysis steps in this circle should be passed preventively and iteratively, if

necessary. As part of the analysis it is necessary to know the relevant loads (during assembly and in operation) in detail, the design of the joint as well as of the gasket must meet the demands, the necessary gasket factors have to be determined, these gasket factors have to be used in stress and tightness analysis and last but not least the

mounting procedure has to be reliable and related to the demands.

INTEGRITY & TIGHTNESS One central point of the analysis of flanged joints is a reliable calculation. Flanged joint calculations can be performed either analytically (ASME, CEN, DIN etc.) or detailed using Finite Element Analysis (FEA), for example. It is necessary that 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.

**ASSEMBLY STRESS** STRESS ANALYSIS TIGHTNESS ANALYSIS

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The first task of a calculation is to

determine the assembly stress level (tightening torque) 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.

Regarding the calculation of flanged joints amtec offers the software package TEMES fl.cal that incorporates the most relevant analytical codes. amtec provides flange calculation services, too.

SOFTWARE AND SERVICES





## Calculation of **Flanged Joints**



For users that work frequently on the field of flanged joints, the flange calculation software package **TEMES**  $_{fl.cal}$  is a reliable tool, based on the state of the art and which is TÜV certified. It incorporates the most relevant analytical codes.

## Software for the Calculation of Flanged Joints



#### Calculation codes and standards

Calculation according

- ASME standards
- EN 1591 (using gasket factors as defined in EN 13555)
- EN 13445





#### Database for geometry and materials

It is possible to put in user defined data for geometry and materials; additionally, the implemented standard database for geometry and materials (for bolts, flanges and gasket) can be used.



#### Load cases

The behavior of the tightening joint is analyzed in pre-defined load steps (input of temperatures, internal pressure, external forces and moments for each step).





#### Calculation

User defined demands regarding assembly stress, tightness class and tightening procedure are part of the analysis.

	pyright amtoc GmbH)
Calculation method	General Loads   Flange 1   Flange faces   Bolis   The second gool. Gasket material Planes 1 material Bolt material Arrentible
EN 1591 💌	Number 1 12 Ann
Type of Bange 1	
Weld neck IL con. sl	
Form R lained facel	Tightening device Torque wench
Tune of Benne 2	Scatter of eingle bott load e 1+ 0.163
Symmetr. Kange 💌	Scatter of eingle bot load e1- 0.163
Flange face 2	Control of bolt load
Forn B (usined face) 💌	Negloct of balt torsion
Type of bolt	Number of te-asceniblys NR 1
Experient hadren	Friction coefficient (thread) at [0.12
no ·	Friction coefficient (nut) un (0.12
Geduet	
Fom IBC 💌	Renaka
Vinion New Constant C	

#### Assessment of the results

As results, e.g., the stresses in the bolts and in the flanges, the gasket stress, the flange rotation and the tightness class are given for every load case.



#### Documentation

The results can be printed on paper, saved on hard disk or transferred to other Windows® applications.



•			calculated: checked: revision:			
Project: * KKS Ident.: *						
Flange: * Page: *						
Flange calculation according to EN 1591-1	I, April 2001			a	inni:	jec
	Symbol	Unit	Assembly	Test Cond.	Service 1	Service 2
Commitment of assembly bolt force				1		
Required assemebly bolt force	Falsen	kN	888			
Maximum allowable bolt force	Palmer	kN	2000			
Chosen assembly bolt force	Fairum	kN	1080			
Corresponding bolt elongation	N	mm	0,03			
Corresponding boll assembly lorque	M	Nm	200			
Maximum Allowable bolt force	Falmer	kN	2000			
Corresponding maximum bolt elongation	Alman	mm	0,06			
Corresponding maximum bolt assembly torque	Maga	Nm	371	1		
Internal forces in subsequent conditions			1			
Gasket force	Fore	kN	1047	767	545	232
	Form	kN	1080	800	577	264
	Firmer	kN	1113	832	809	297
Bolt force	Film	kN	1047	911	813	669
	Piere C	kN	1080	944	845	701
Cashed and one among an	0.	MDo	1113	976	311	/35
Cashe, actinos presidire	9	MPa	419	310	224	103
	Q <sub>ne</sub>	MPa	431	323	238	115
			-			
Checking the tightness criteria	-	-				
Commission of the minimum remained nasket stress	0 2 0	-	0.k	01	0 k	0.k
Checking the admissibility of the load ratio						
Bolts						
Load ratio			0,30	0,22	0,35	0,17
Record Allowable load only			0.8.	0.8.	0.8.	0.K.
Resistance of flatore 1	We	Nmm	7.04E+07	8.95E+07	4 64E+07	6.64E+07
Load ratio	95		0.33	0.31	0.50	0.37
			0.8.	0.8	0.8.	o.k.
Flance 2 Allowable load ratio	• • • • • •		1.00	1.00	1.00	1.00
Resistance of flange 2	W <sub>p</sub>	Nmm	6,51E+07	6,42E+07	4,28E+07	6,13E+07
Load ratio	05		0,38	0,33	0,53	0,39
-			0.k.	o.k.	o.k.	o.k.
Gasket Load ratio	• • •		0,22	0,15	0,11	0,05
			0.8.	o.k.	o.k.	o.k.



> Those users who run into flanged joint calculation needs only every once and a while might prefer the comprehensive **amtec flange calculation service**. It is tailored to the real needs, performed by experienced engineers.

## Flange Calculation

Medium

**p**, ∆**p** 

T, ∆T F

Medium

p, ∆p T, ∆T

FM

м

as a Service



We use our own software if analytical approaches are convenient. Especially in the case of special designs that are not covered by analytical methods, additionally, we perform calculations using Finite Element Analysis (FEA).





CALCULATIONS ACCORDING TO ASME CEN DIN CALCULATIONS USING THE

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FINITE ELEMENT ANALYSIS (FEA)

STRESS ANALYSIS FATIGUE ANALYSIS TIGHTNESS ANALYSIS

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ANALYSIS OF EVERY RELEVANT PARAMETER APPROPRIATE DESIGN RELIABLE ASSEMBLY AND TIGHTENING FEEDBACK OF EXPERIENCE



As said above, it is necessary to perform an integral analysis; this analysis has to cover every parameter that can be of influence to integrity and tightness of a flanged joint. Only on this basis an assessment can be reliable. **amtec** offers comprehensive tools and advanced services for every aspect of this analysis:

#### amtec services

#### Loads

Loads like internal pressure, temperature and their transients (even dynamic loads) are input data to every flange calculation. Therefore, **amtec** offers services regarding monitoring of the real loads.



#### Gasket factors

**amtec** manufactures test equipment for gaskets. Therefore, **amtec** is the first choice for services regarding determination of gasket characteristics. This makes the selection of the most effective gasket easier.

#### Calculation

Calculations are performed following analytical approaches as well as using the Finite Element Analyisis (FEA). Realistic boundary conditions and gasket factors are used.

#### Assembly and tightening

Consulting according assembly and tightening of flanged joints, tools for controlled assembly and tightening of joints (like hydraulic spanners), tightening of joints as service.

#### Flanged joint database

Database tools for joint integrity management systems.





# Integral Procedure



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

PROTECT

ENVIRONMENT

### Training, Consulting

**amtec** provides workshops on flange calculation. Visit our website for actual dates of training courses and workshops.



**amtec** provides advanced tools and services for:

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





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