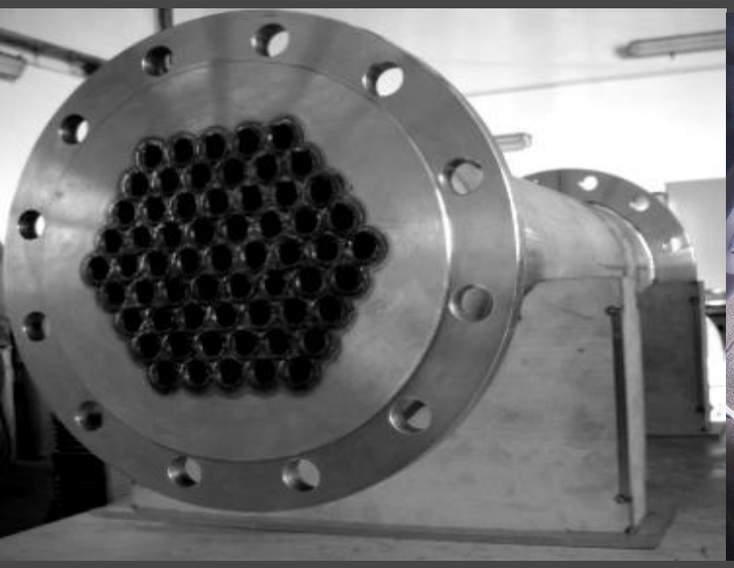
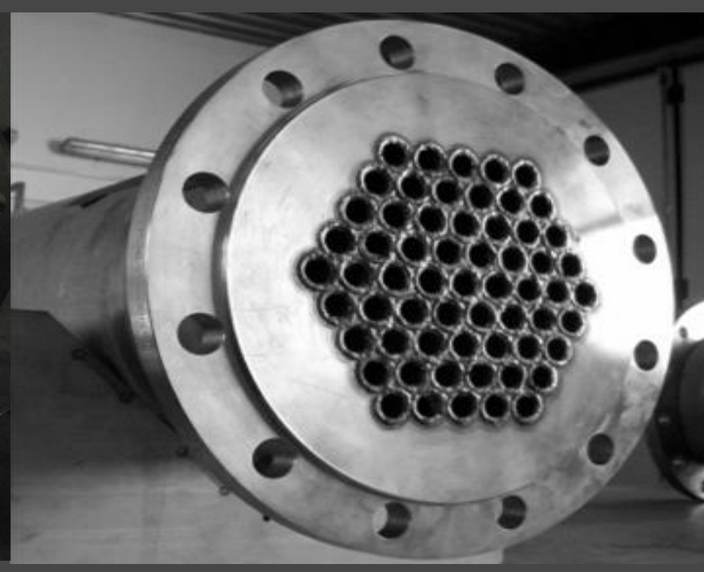
TECHNICAL CONFERENCE
2015
CZECH REPUBLIC

Contribution to the issue of the production of heat exchangers
for technological equipment in the energy sector





PROGroup Engineering®

Contribution to the issue of the production of heat exchangers for technological equipment in the energy sector

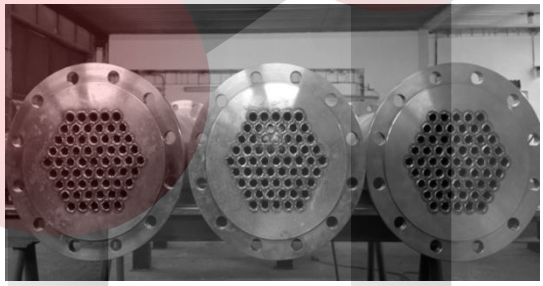
Josef Nejedlý [1)]

1. Introduction

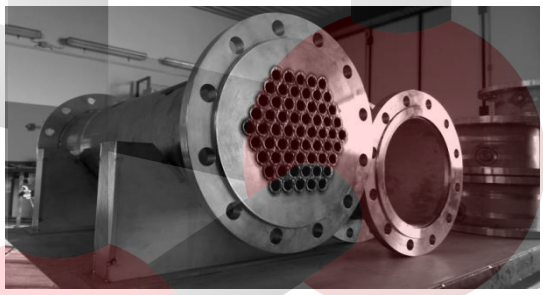
Heat exchangers are among the technological equipment, that is used to exchange heat between the grids, and objects of different parameters. Occurs for them to transfer the heat from the heating medium in the media of warmed. Heat exchangers will always be proposed for specific use in the operation. The purpose of these facilities in the energy sector are heating fluids, cooling fluids, condensation of the steam, the use of waste heat. the production of steam.

2. Requirements for heat exchangers and heat-carrying medium, [1], [2], [3], [4]

THE BASIC REQUIREMENTS FOR HEAT EXCHANGERS

	Optimization of the dimensions and construction Minimize pressure losses Thermal performance The maximum operational reliability Maintenance of equipment Durability and price	

THE BASIC REQUIREMENTS FOR THE HEAT-CARRYING MEDIUM

	The big unit capacity High heat conductivity coefficient High heat transfer coefficient The optimal relationship between the temperature and the varnish Low aggression leading to corrosion In terms of health and safety	

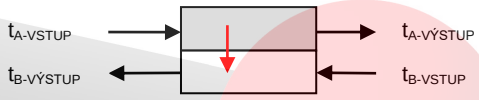
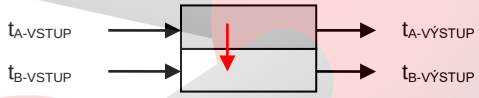
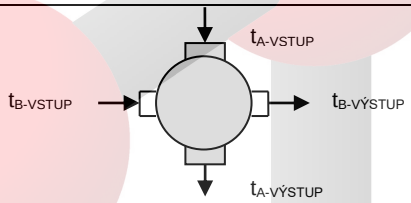
USE IN INDUSTRY

	Chemical industry	Boilers, radiator, evaporator, condensers, etc.
	Petrochemical industry	Reboilers, vaporizers, etc.
	Nuclear facilities	The selected device and the selected device specially designed for nuclear facilities

3. The basic distribution of heat exchangers, [1], [2], [3], [5], [6]

ACCORDING TO WORK MARCH	ACCORDING TO THE METHOD OF HEAT TRANSFER
Heat recovery Regenerative Contact Mixing	Conventional Radiation Combined

ACCORDING HEAT FLOW BEARER

Counter-current	
Wakes	
Cross-flow	

ACCORDING TO THE PURPOSE	ACCORDING TO THE CONSTRUCTION
Heaters Cooler Vaporizers and evaporator Capacitors Separators and super heaters	Tubular - Twin pipe - Boiler - Air - Twisted tube Board Spiral Special

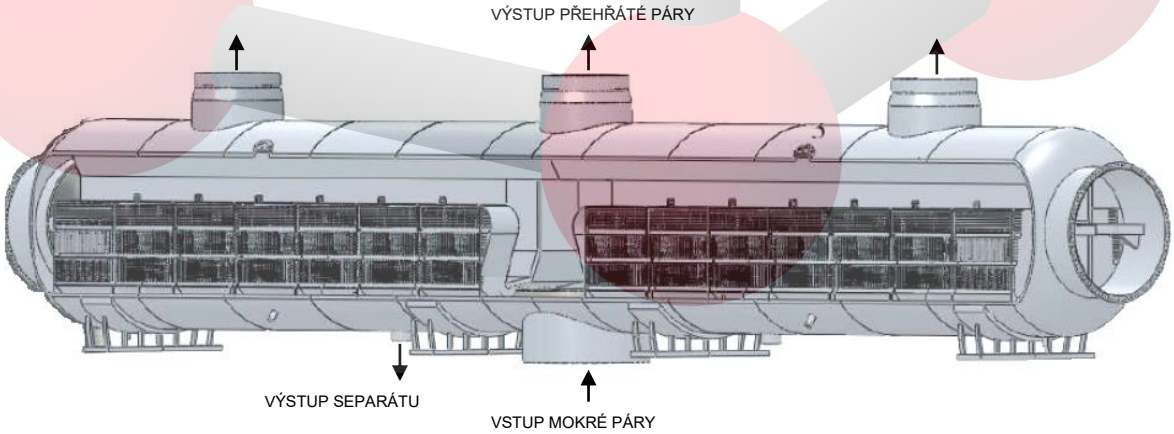
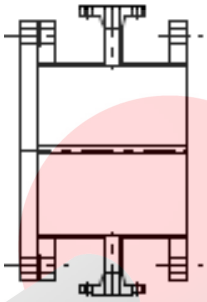
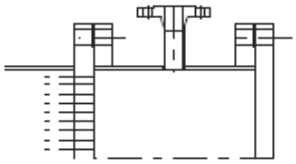
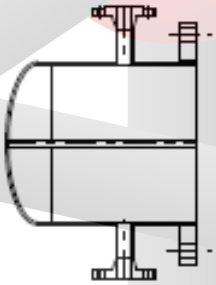
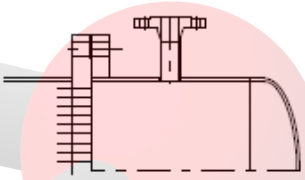
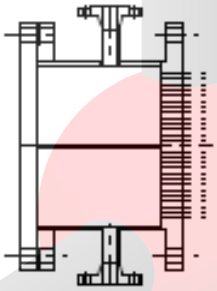
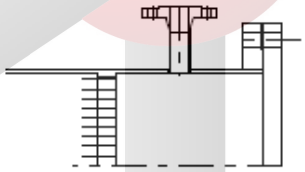
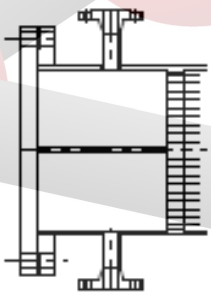
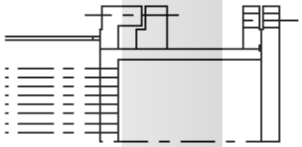
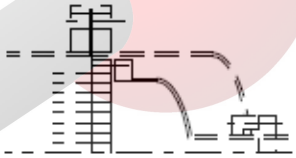
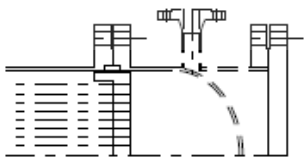
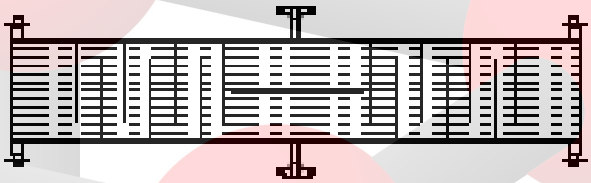
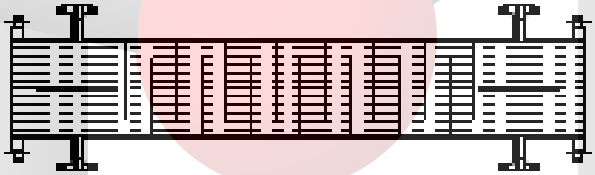
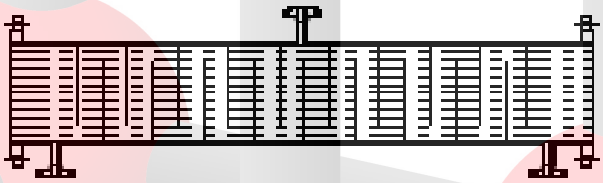
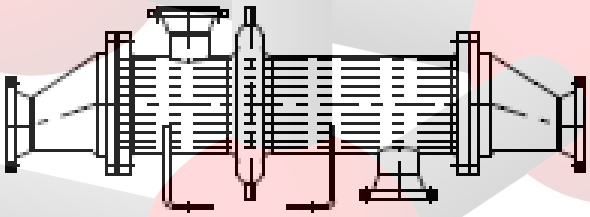
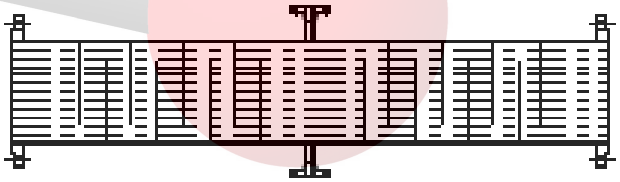


Fig. Sample design of the separator, the secondary circuit - VVER 1000, [6]

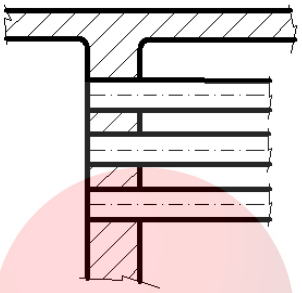
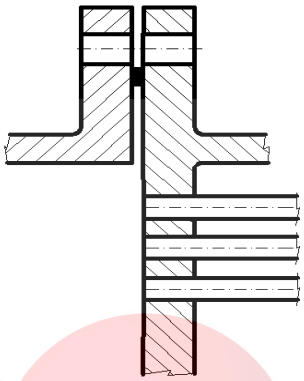
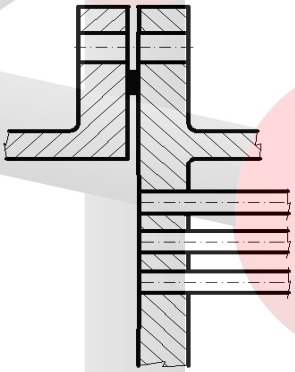
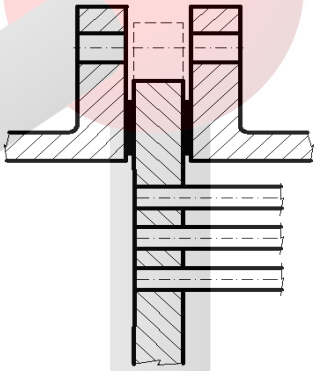
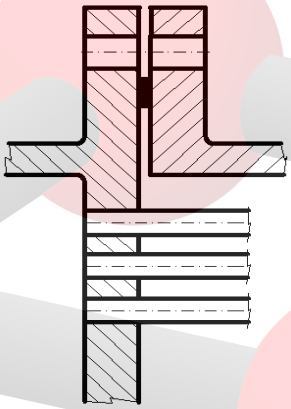
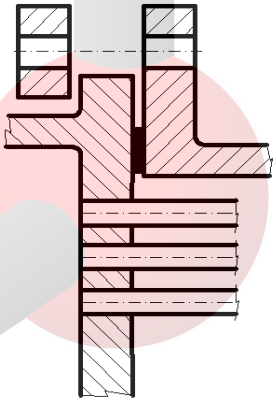
4. Distribution of tubular heat exchangers according to the standardization TEMA - Tubular Exchanger Manufacturers Association, [4]

TYPES OF LEADING TITLES			TYPES OF BACK TITLES		
A	removable head and flange detachable necks		**L**	removable head and flange detachable necks	
B	removable head with a fixed elliptical and on the necks		**M**	removable head with a fixed elliptical on the day, the socket fittings and fixed a tube plate	
C	removable head with fixed a tube plate, detachable flange and the necks		**N**	head associated with the jacket and fitted with a detachable flange	
N	the head associated with the jacket and fitted with a detachable flange		**P**	floating head	
D	Special		**S**	floating head with a tube plate between flanges	
			T	floating head with a loose a tube plate	
			U	U-tubes	
			W	with floating mantle	

TYPES OF MANTLE SPACES

E	input	
F	two-start	
G	simply split skirt space	
H	double split skirt space	
J	partitioned server	
K	special	
X	the cross-flow	

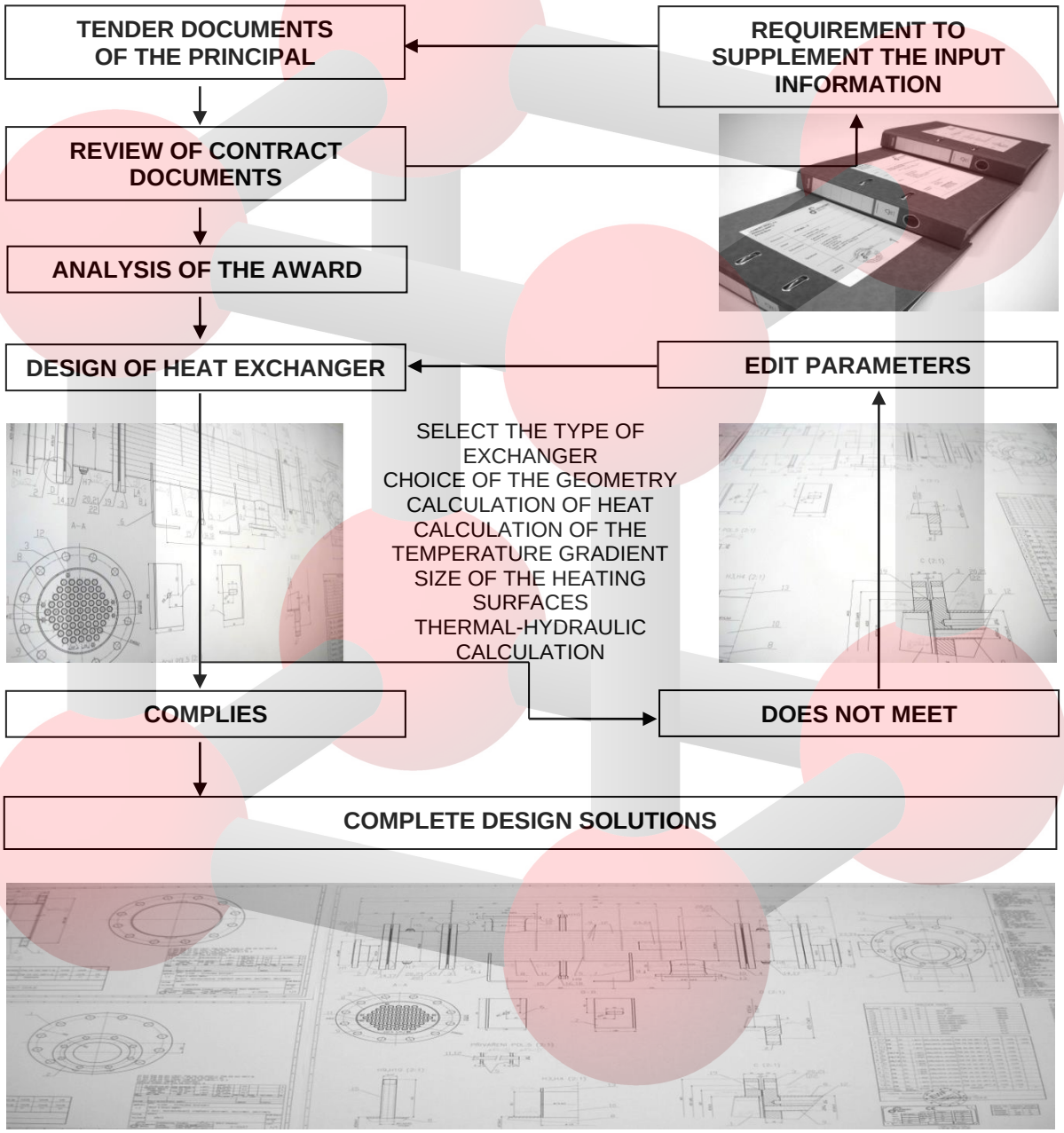
DESIGN OF SHEATH TUBE CONNECTION ACCORDING TO TEMA

Tubesheet integral with a jacket and Chamber 	Tubesheet integral with a flanged edge of jacket and tight to the Chamber 
Tubesheet integral with a jacket and tight without flange edges to the Chamber 	Tube sealed flanged edge or without him to cloak and Chamber 
Tube with a flanged edge of the sealed Chamber to cloak with an integral 	Tube without flange tight to the edges of the mantle Chamber 

5. Process of preparing the production of tubular heat exchangers designed for technological equipment in the energy sector, [1], [2], [3]

The process of production of the type heat exchangers are according ASME VIII provides. According to European standards for pressure equipment according to EN 764 - pressure equipment EN 13445 - unfired pressure vessels.

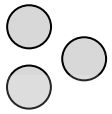
PROCEDURAL STEPS IN THE DESIGN OF HEAT EXCHANGER



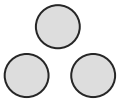
6. Design and calculation design of tubular heat exchangers, [1], [2], [4], [5], [6]

DESIGN OF HEAT EXCHANGER GEOMETRY-ARRANGEMENT AND SHAPE OF THE PIPES

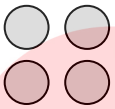
Triangular 30 °



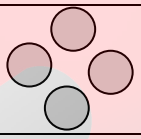
Revolving triangular 60 °

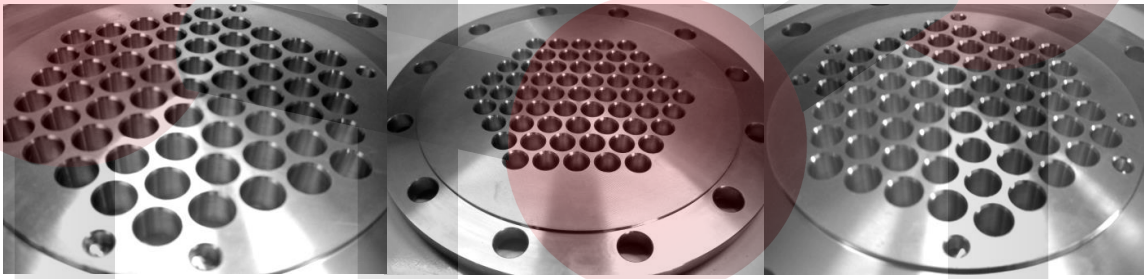


Square 90 °

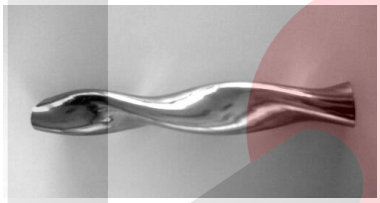


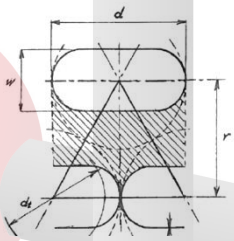
Revolving square 45 °

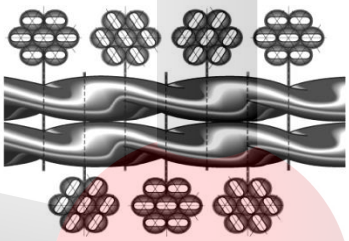




Shaped tube type twisted tube

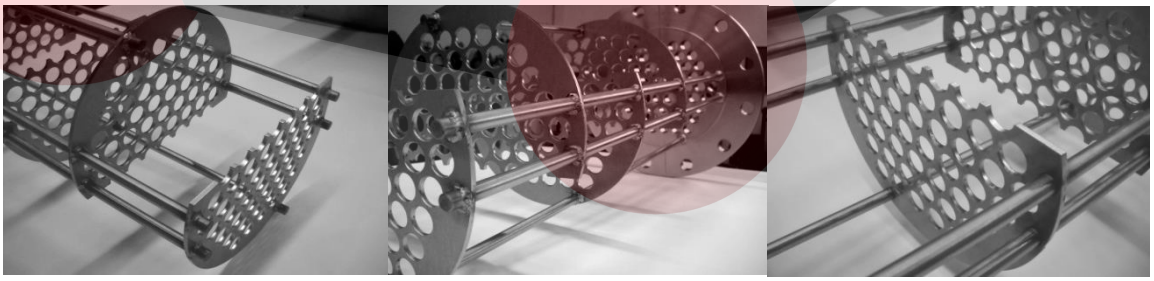




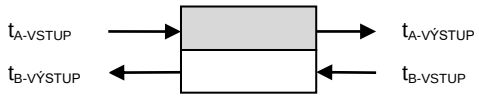
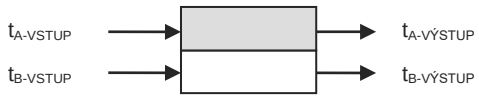
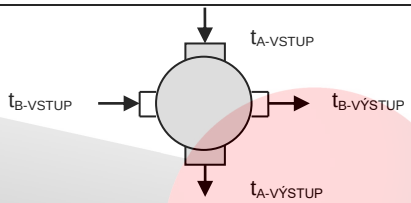


DESIGN OF THE HEAT EXCHANGER GEOMETRY-GEOMETRY OF BULKHEADS

Segment of the bulkhead
Helical bulkheads
Bar counter



DESIGN OF HEAT EXCHANGER GEOMETRY – SOLUTIONS INVOLVEMENT

Counter-current	
Wakes	
Cross-flow	

DESIGN CALCULATION OF HEAT EXCHANGER – DESIGN AND CALCULATION OF CONTROL

Design calculation, the inputs are: Type heat exchanger; The kind of working substance; Temperatures, pressures of working substances; Mass flow rates; Permissible pressure loss; For more defined operating conditions; **Calculation of control inputs are:** The input temperature and pressures of working substances; The flow rates of the working substances;	**Design calculation, the outputs are:** Determination of the size of the heat exchange surfaces, (A); Geometric arrangement, effective length of pipe (L); **Calculation of control outputs are:** Output temperature (tA, tB); Pressures of working substances;

HYDRAULIC CALCULATION SOFTWARE-HEAT CALCULATIONS

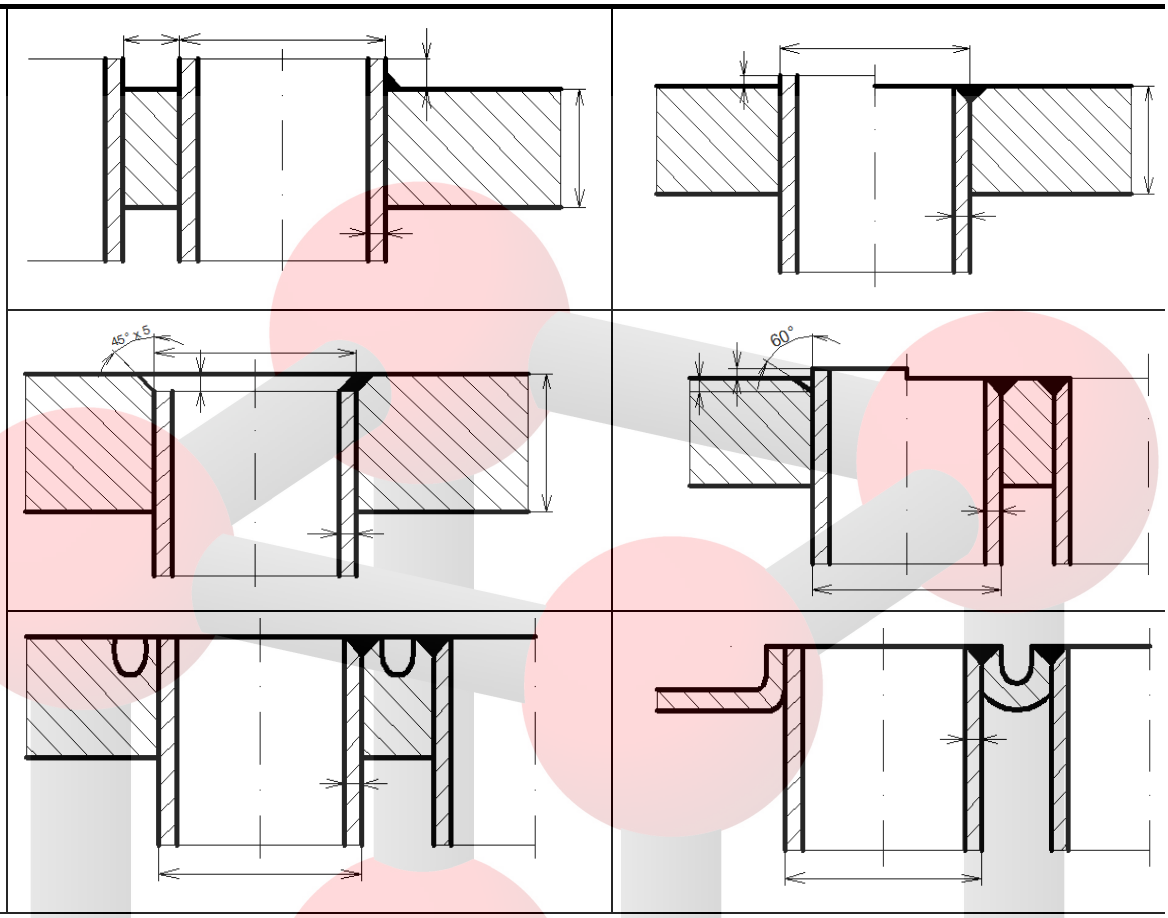
HTRI *Xchanger Suite*	CHEMCAD

CALCULATION SOFTWARE-STRENGTH CALCULATIONS

VVD *Visual Vessel Design* AutoPIPE	SANT AMBROGIO ANSYS *Workbench*

7. Welds and welding technology, [1], [2], [3], [4], [6]

BASIC TYPES OF WELDED JOINTS – BUSHING TUBE BUNDLE



QUALIFICATIONS WELDED JOINTS PIPE- TUBESHEET ACCORDING TO EN ISO 15614-8

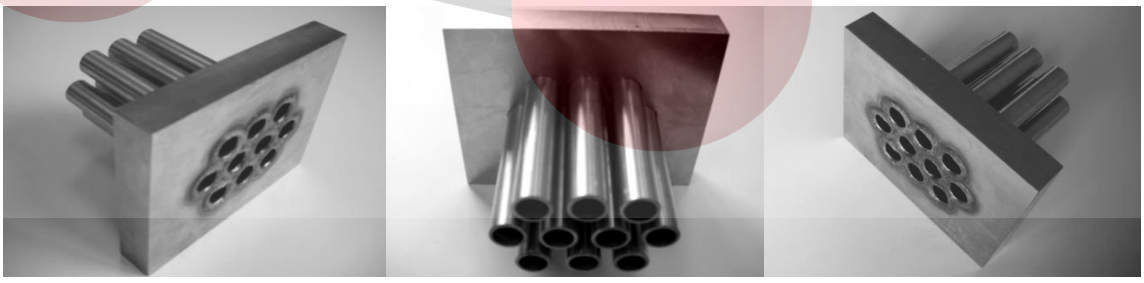
For a triangular arrangement, must be:

Welded pipe ends 10 D < 40 mm;
Min. 7 welded pipe ends D ≥ 40 mm;

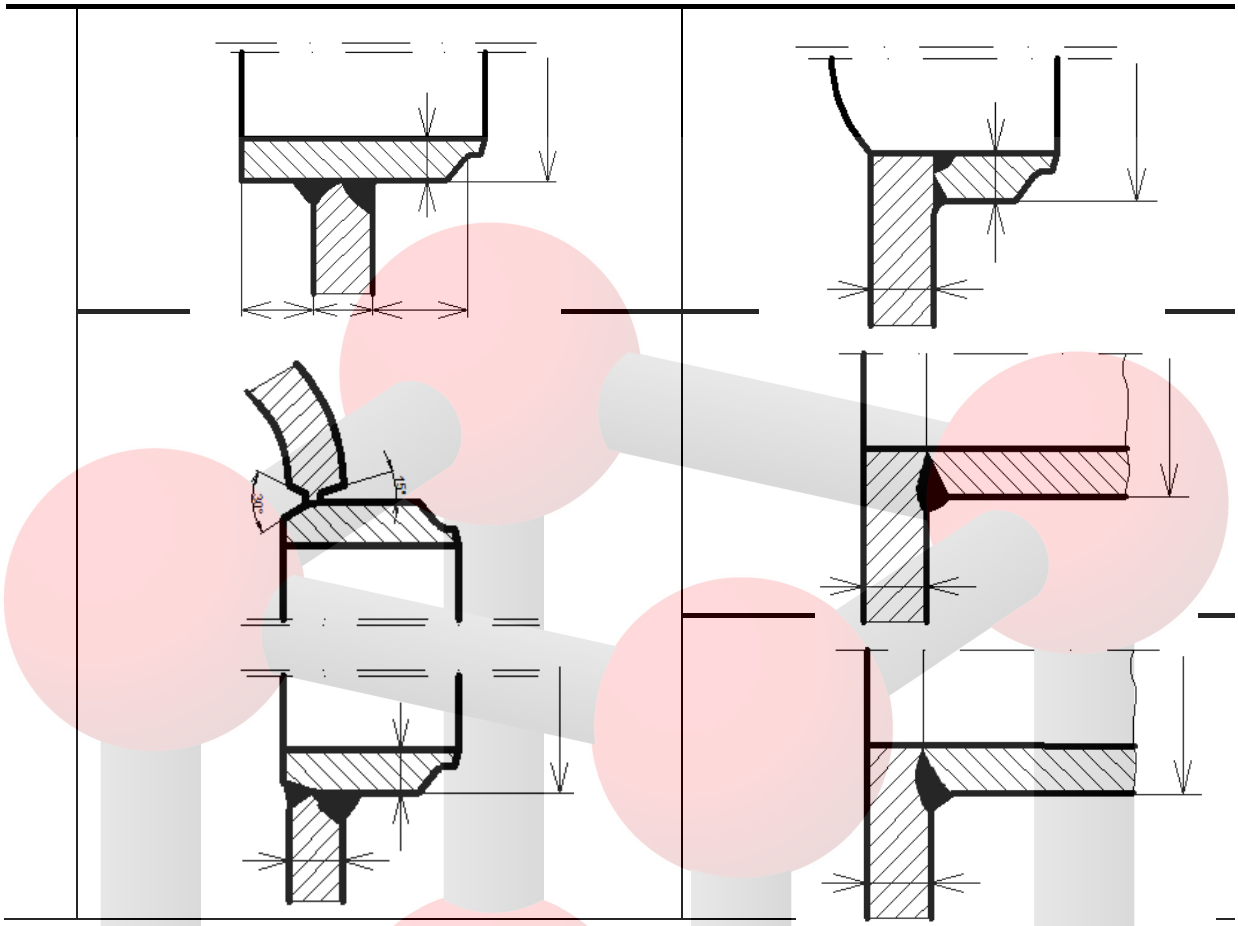
For a square arrangement, must be:

Welded pipe ends 12 D < 40 mm;
Welded pipe ends, min. 9 D ≥ 40 mm;

Preparation of connections according to EN 26692;
Designs services according to EN 1708-1;
Controls for qualification welded joints WPQR: VT, PT, RT 100%; macroscopic examination (EN 1321), hardness test (ISO 9015-1);



BASIC TYPES OF WELDED JOINTS CONNECTIONS SLEEVES



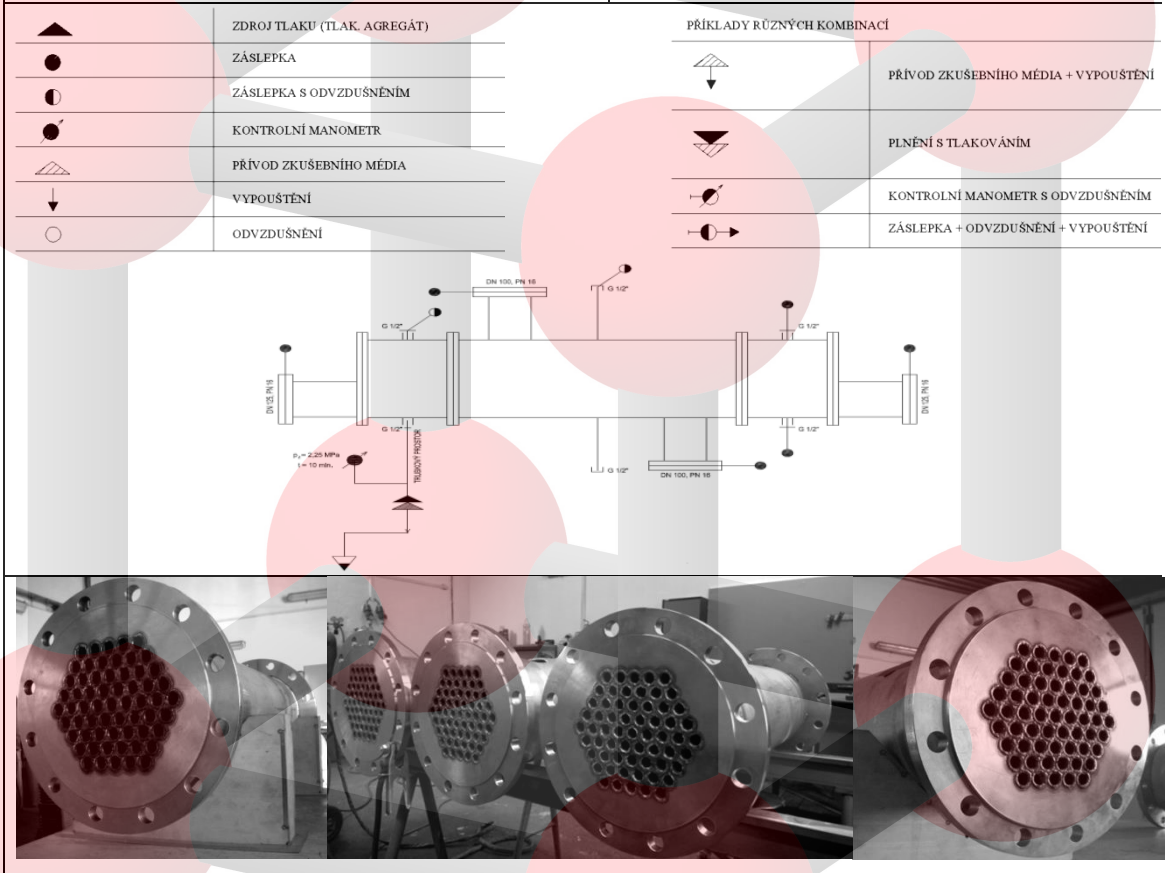
WELDING TECHNOLOGY

Manual technology Gas Tungsten Arc Welding, GTAW	**Automated technology-orbital welding** Gas Tungsten Arc Welding, GTAW Laser welding using laser heads COAX in combination of industrial articulated robot.

8. Pressure strength and leakage test on tubular heat exchangers, [1], [2]

THE FIRST CONSTRUCTION AND PRESSURE TEST THE STRENGTH TEST

The output of the test heat exchangers in production are carried out according to the regulations of EN 13445. Building test; Pressure test tube space; Leakage test tube space; Pressure test of space; Leakage test area; Default revision;	The output of the test after the installation of heat exchangers is carried out according to EN 13445. Tightness test tube space behind the operation; Leak test, the space behind the operation; Program of the functional tests; Operational review;



9. Discussion

This contribution wants to point out the importance of process design and technological preparation of production of tubular heat exchangers, which are intended for the technological equipment in the energy sector.

10. Conclusion

Contribution to the issue of the production of tubular heat exchangers describes the main principles of design and technological preparation of production of tubular heat exchangers, which are designed to power equipment.

The aim of this contribution is to bring the structural design, including the technological preparation of production, due to the significant impact of this process on the life, the safety and functionality of the device in the construction of new and reconstruction of existing technological units in the energy sector.

11. Acknowledgement

We would like to thank the Faculty of Mechanical Engineering, Department of Welding technology and Surface Treatment, Foundry Department and cooperating companies PROGROUP ENGINEERING, PROFLUID, TESYDO for cooperation and taking part in the experiment.

References

[1] NEJEDLÝ J..: Technical documents, 2015.
[2] NEJEDLÝ J.: Project management in nuclear power engineering, 2012.
[3] NEJEDLÝ J.: Technology of production and Assembly of technological equipment in energy, 2014.
[4] TEMA Standards, Tubular Exchanger Manufacturers Association, Inc.
[5] LUŤCHA J.: Design of the heat exchanger type twisted tube, Brno 2011.
[6] ŽITNÝ R.: Thermal equipment TZ4, Institute of process engineering, and FS ČVUT Prague 2010.

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