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COMPARATIVE ANALYSIS OF DESIGNS OF SPECIAL TECHNOLOGICAL CONTAINERS FOR CHEMICAL HEAT TREATMENT

Special technological containers for chemical heat treatment (STC for CHT) operate under severe service conditions including high temperatures (up to 950–1050 °C), cyclic thermal loads, mechanical stresses and aggressive process atmospheres. During heating and subsequent quenching of workpieces, significant temperature gradients arise in the container structure, leading to thermomechanical stresses and thermal fatigue. At temperatures close to 1000 °C the creep resistance of the material also becomes an important factor determining the service life of the container.

Cast containers allow the implementation of geometries close to optimal from the standpoint of thermal stress distribution. Smooth section transitions and the absence of welded joints reduce stress concentrations during thermal cycling. Cast Fe–Cr–Ni heat-resistant alloys also demonstrate good creep resistance at high temperatures. However, cast structures are typically heavier and may contain casting defects.

Welded containers manufactured from rolled heat-resistant steels can be designed as thin-walled structures, which significantly reduces their mass and improves the mass utilization factor. At the same time, welded joints and heat-affected zones represent structural heterogeneities that may reduce high-temperature strength and increase crack susceptibility under thermal cycling.

Modern developments include modular and hybrid STC for CHT designs**.** In hybrid systems, a cast load-bearing frame may be combined with lightweight welded or mesh modules. Such an approach allows the integration of high structural strength with reduced mass and improved openness of the container structure, which enhances heat and mass transfer.

The analysis shows that the most promising direction is the development of open-type hybrid STC for CHT, combining cast supporting elements with replaceable lightweight modules and enabling the future use of ceramic or composite components with high resistance to high-temperature chemical environments.