SELECTION OF SUITABLE ROOF DESIGNS FOR OIL TANK RECONSTRUCTION

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The vertical, cylindrical steel tanks used at petroleum product storage centers and refineries are subjected to intense corrosion. However, different tank types corrode at different rates. As a result, each time the tanks are overhauled the same structures and parts which are most heavily corroded must be replaced.

These tank structures include the roofs, their supporting elements (girders, beams, trusses) and one to three upper belts of the hull [1]. Corrosion is particularly nonuniform in the roof trusses in which the upper belts and the upper parts of the framework are permanently in a vapor–air medium, while the lower belts and the lower parts of the diagonal struts and posts are in the zone of the varying oil level (Fig. 1). The vertical elements of the girder framework, the posts, are least subject to corrosion. The upper belts of the trusses and the roof girders corrode more. Very intense is the corrosion of the lower belt of the roof trusses, particularly the joints (Fig. 2).

The corrosion damage at the joints has the form of perforations in the steel profiles and damage to the fasteners; cover plates, bolts, nuts and welding seams. As a result of this corrosion damage, cracks and gaps appear between the components of the joints. An example of a typical corrosion damage of the joints of the lower belts of the roof trusses is the joint in the lower belt of the roof girder of the reservoir at the Novokuibyshev refinery, which after eight years of service is in an advanced state of disintegration (Fig. 3, a, b).

When the corrosion products were removed from the surface of the joint it could be seen that the most rapid attack on the metal occurred in the exposed parts of the steel profile and also on the upper side of the angle bars of the lower girder belt. Measurements of the extent of corrosion showed that the metal loss in the exposed parts of the steel profile was six times greater than that in the covered parts. The nuts, belt heads and bolt shafts corrode and assume a conical shape, while the shafts stretch as well. The cracks between the angle bars and the joint profile increase to 4-6 mm with frequent damage to the welds and breaking off of the angle bars from the profile steel.

A typical feature of the damage to the joints in the lower belt of the roof girders is the intense destruction of the elements of the framework at the points of contact with the joints. At these points, owing to intense corrosion of metal, the profile section is greatly reduced and the profile is then completely destroyed. As a result, the framework elements break out of the joint profiles. The horizontal flanges of the angle bars suffer most from corrosion; the vertical flanges corrode more slowly. Figure 4 shows several joints of roof girders from a reservoir at the Order-of-Lenin Refinery at Ufa, which have been completely destroyed by corrosion in eight years of service.

The destruction of the joints of the girders in the lower belts of the tanks is a consequence of their incorrect design, because mechanical impurities contained in the crude oil and products of metal corrosion are deposited on these joints in considerable quantities. During the periodical variation of the level of the crude oil and oil products in the tank, the deposits which have accumulated on the surface of the joints are washed off and the corrosion of the bare parts is intensified.

On the joints in the upper belts of the girders which are always in a vapor–air medium, mechanical impurities do not accumulate and their corrosion is therefore much more uniform.

Thus, the intense corrosion of the joints in the lower belt of the girders necessitates frequent overhauls of the oil tanks for which considerable material and money is expended. Furthermore, owing to the frequent repairs of the tanks, production difficulties are caused in the operation of the crude oil bases and raw material tank farms of the refineries.

The peculiarities of the corrosion of the girders show that the modernization of the existing tanks requires an improvement in the design of the tank roofs. A longer service life of the roof constructions can be attained by greatly reducing the number of focal points of local corrosion attack. For this purpose it is indispensable to remove the

Fig. 1. Corrosion zones of petroleum tanks: 1) vapor-air medium; 2) zone of variable oil level; 3) liquid medium.

Fig. 2. Nature of the corrosion damage to the supporting structure of the roofs of steel petroleum tanks.

Fig. 3. Corrosion damage to the intermediate joint of the lower belt of the girder framework in the tank of the Novokuibishev refinery park for refined products and crude oil, after eight years of service: a) frontal view; b) top view.

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The plan proposed in 1966 by the Central Scientific Research Laboratory of Glavneftesnab of the RSFSR for the modernization of the roofs of existing tanks with roof girders [2] does not solve the problem of increasing the service life of roof constructions because the lower belt of the girders, which have been reduced in height, still remains in the zone of varying oil level and vapor-air space and to achieve a maximum simplification of their design.

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A more radical solution of this problem is to position the roof supporting framework on the outside of the tank [3]. The possibility of the appearance of local corrosion on the smooth internal surface of the tank roof is greatly reduced and the conditions for the application of anticorrosion coatings are improved.

A design has been developed for tank roofs in which all elements of the supporting frame (beams, girders, etc.) are situated on the outside and the roof (sheet metal) inside the reservoir [4]. This design consists of individual transportable shields which are made at the factory and enables high-quality protective coatings to be applied to the inner