Modern methods of reconstruction of chimneys

Alexander Elshin, Chief Consultant, Vysotnik Group , Ekaterinburg

Vladimir Astashkin, Professor, Doctor of Engineering

Vladimir Luzhkov, PhD, Deputy Director, South-Urals State University, TOR Engineering Co. Ltd., Chelyabinsk

The changes in operating conditions directly linked with compliance with the Kyoto Protocol requirements and Energy Strategy lead to destroying the load-carrying structures of reinforced concrete and brick chimnes stems of chimneys with traditional construction.

A new progressive method of reinforced concrete stems constructive security recovery has been developed by *TOR Engineering Co, Ltd.* (Chelyabinsk). It is a method of shoring the chimney stem by a reinforced concrete ring-shell, which pecu-

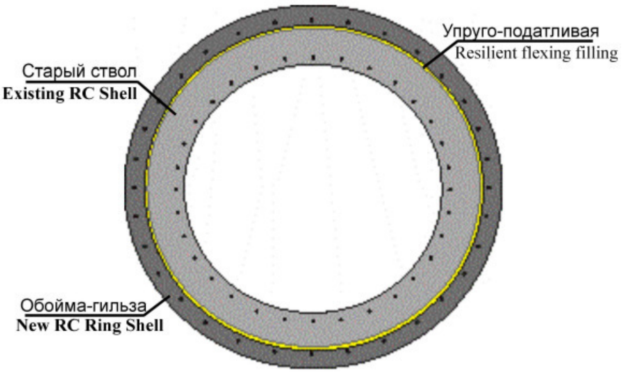

Fig. 1. Scheme of Shoring the Chimney Reinforced Concrete Stem with a Ring-shell.

Fig. 2. Shoring the stem of H=60 m chimney of Magnitogorsk Sintering Plant

Fig. 3. Magnitogorsk Sintering Plant RC Chimney H=90 м after reconstruction

liarity is that there is a resilient flexing filling between the old stem and the new ring (See fig. 1.).

As a result of such solution, the outer ring does not add its load to the concrete of the existing stem. At the same time, the ring-shell takes over a half of wind load and decreases by several times the temperature stresses in the stem being shored.

In 2004, in accordance with this elaboration, Yuzhuralteploproekt Close Corporation (Chelyabinsk) designed, and Vysotnik Close Corporation (Ekaterinburg) implemented in 2005 a reconstruction of reinforced concrete stem H=80 m of Magnitogorsk Metallurgical Combined Works Public Corporation sintering plant.

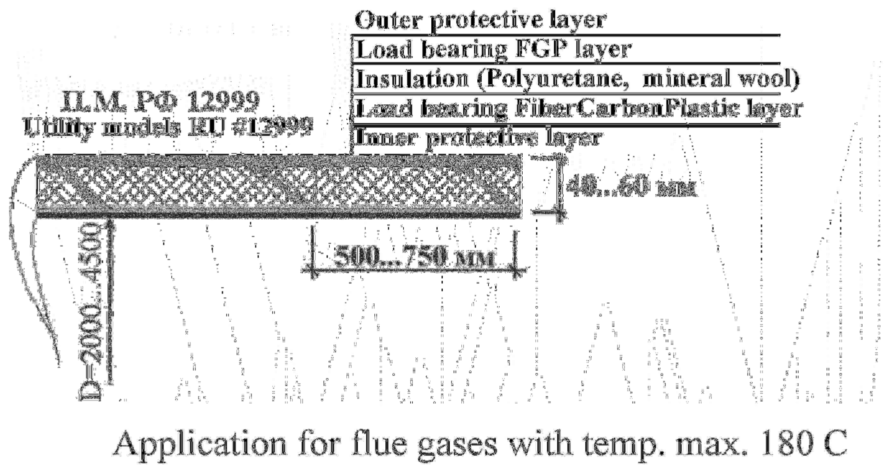

Fig. 4. Three-layer Construction of Fiberglass Plastic Stem with Light Filler

Another progressive trend in reconstructing and constructing chimneys and ventilation ducts in conditions of decreasing temperatures and increasing flue gases corrosiveness is the use of gas-escape channels made of polymeric composite materials (PCM). An important role in the process was played by the change of price ratio for basic construction corrosion-resistant metal and non-metal materials in favor of the latter.

The price for PCM gas-escape channels is 2.5… 4 times lower than it is for analogous ones made of high-alloy and intermediate-alloy steels and non-ferrous metals with an equal no-service lifetime. The price for heat-insulated stems of mild steel with an internal corrosion-resistant paint coating is comparable with that for PCM stems, while the lifetime for the latter is 3-5 times longer.

Technical and economic calculations we have made have shown that in case of reinforced concrete chimney reconstruction with removal of the top part of the stem, the most economical option is a metal frame superstructure with installation of an internal stem. At the same time, installation of PCM stem leading to a certain lump-sum costs increase, is made up for by significantly lower operation, inspection and repair costs, as well as a longer life time.

A low weight of gas flues and gas-escape channels casings plays a significant role during reconstruction of existing structures. Because of corrosive wear of element, a number of frame towers and platforms are not capable of carrying the load of metal rubberized gas-escape channels and gas flues weight, and when these constructions are substituted by plastic ones, the remaining carrying capacity of structures is enough for perception of operational loads.

Constructively, the gas-escape channel is constructed as separate side-bars up to 10 m in length with faucet joint of mounting elements. The elements are hung on main frame carrying construction apertures with a further hermetic encapsulation of sockets. At the same time, as a rule, the offset of gas-escape channel is situated 2…3 meters higher than that of the carrying construction, which makes impossible self-enveloping of the chimney and head destruction.

Generally, a gas-escape channel wall includes:

internal chemically stable layer 2..3 mm thick on polymeric increased heat-resistance binders with 5…10% glass mats reinforcement on the basis of E-, C-glasses;

external constructive layer 5..15 mm thick on polymeric standard-purpose binders with glass fabrics reinforcement;

fireproof layer 0,8…1 mm thick on fire-resistant binders or with the use of polymeric fireproof mastics, for instance, “Ograx B/BB”.

However, a drastic decrease in fiberglass plastic mechanical properties at increased temperatures (80…100 ^{0}C), as well as the need for ensuring premounting and mounting rigidity forces the designers to increase substantially the thickness of fiberglass plastic wall.

While developing the methods of fiberglass plastic constructions production, with the aim of decreasing the level of temperature stresses and material capacity, as well as for simplification of gas-escape channels and gas flues casings constructions, the South Urals State University together with TOR have developed a sandwich construction of the wall: **protective layer – fiberglass plastic – light filler (heater) – fiberglass plastic.**

The introduction of medium layer – light filler made it possible:

to insulate external power fiberglass plastic layer from the negative temperature effect of exported gases and, having decreased the level of temperature stresses, to widen the temperature range of constructions application;

to increase the bending resistance of the wall, to ensure local stability of the wall without stiffening ribs and get a 4-5 times decrease in constructions material capacity.

The method of skew reeling of glass fabric impregnated with a binder makes it possible to get finished casings within one technological cycle, decreasing their production time by 5 times. Besides, the method of skew reeling allows for production of oversized casings with the diameter of up to 5,0 m and length up to 8 m on mobile units in direct proximity to the mounting site. The increase of side-bars length allows for decreasing the number of mounting and enlarging junctions, while the use of mobile units makes it possible to virtually eliminate transportation costs, which make up to 15% of prime costs for such constructions when they are produced at a plant.

The technology of gas-escape channel production makes it possible without additional costs to improve aerodynamic characteristics of heating unit gas-escape track. It is achieved by putting a parabolic diffuser in the top part of the stem. The parameters of the diffuser ensure minimum hydraulic resistance in the given range of flue gases speeds.

The constructions described above are in operation at Chelyabinsk Electrolytic Zinc Plant (1997, gas flue L=60 m, D=1,0), at Bratsk Aluminum Plant (4 chimneys H=60 m, D=2,0 m), at Chepetsk Mechanical Plant (3 chimneys H=80…120 m, D=2,0…2,8 m), at Karabash Brass Works (gas flue L=60 m, D=2,0 and chimney H=40 m, D=2,0 m). Gas flues with the total length of ~400 m have been produced for vent systems of Irkutsk Aluminum Plant and Chepetsk Mechanical Plant.

Conclusions:

The method of shoring reinforced concrete chimneys with a monolithic ring-shell with resilient flexing filling allows to take a substantial load off the worn-out constructions and increase their life time.

In the conditions of decreasing the power consumption of production and changing the fuel and energy balance of heating systems, the use of fiberglass plastic gas-escape stems is one of the most effective methods of reconstructing the traditional constructions of chimneys.

The most progressive construction of a fiberglass plastic stem is a sandwich construction produced at mobile units near the mounting site.