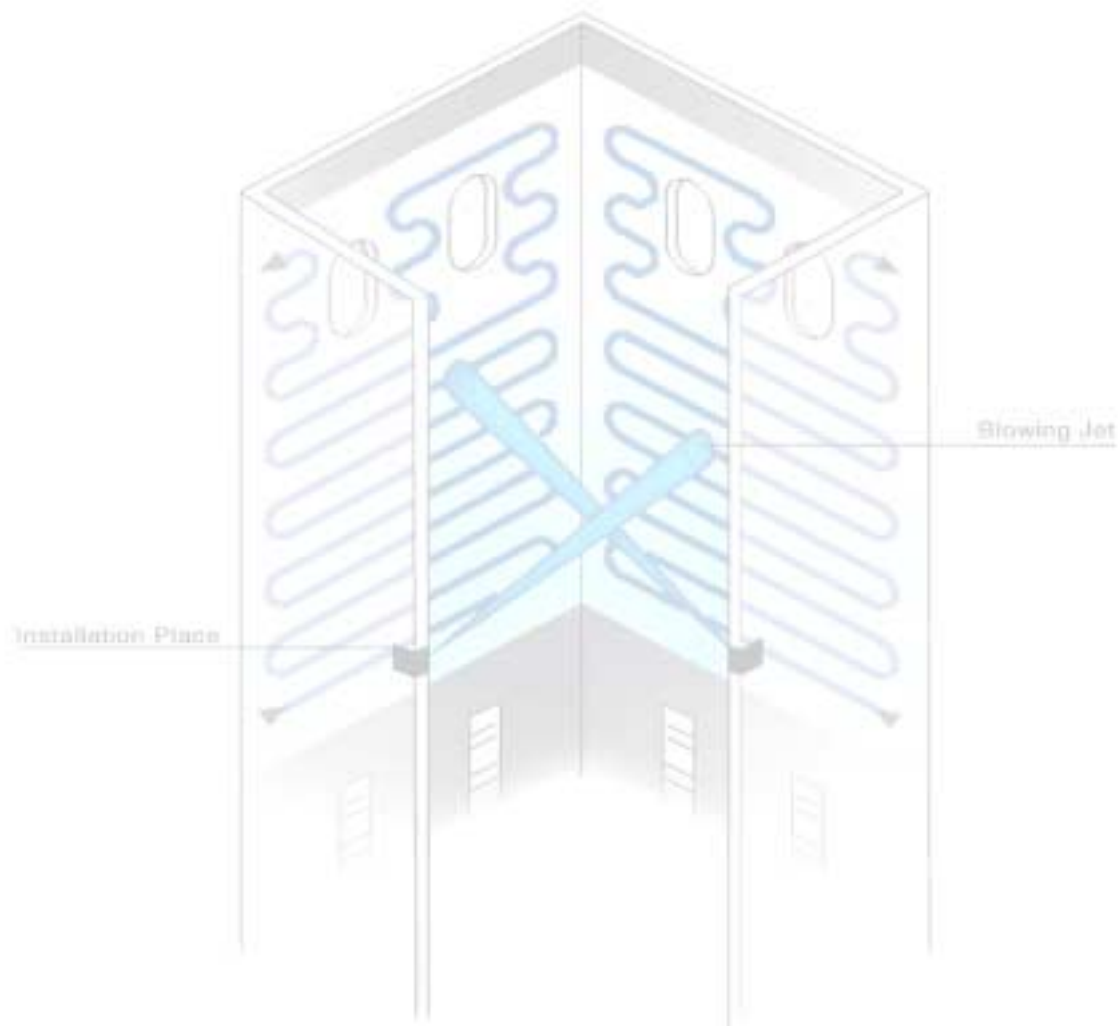


Water Cannons for cleaning membrane walls of a 600 MW lignite-fired steam generator



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Operating experiences

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Introduction

The steam generators operating at base load at the Weisweiler Power Station are provided with fuel from the Inden open-pit lignite mine. Flue gas excess pressure from possible hot standby operation has not been considered in the design of the heating surface cleaning.

At the Weisweiler Power Station water blowers are used for cleaning the furnace of the small steam generators. For cleaning the furnace of the 1900 t/hr steam generators G/II Water Cannons (WLB) are applied. For this, a test WLB was installed already in 1992 and numerous measurements were performed regarding wall temperature loading during cleaning by Water Cannons. In the first step four Water Cannons were installed in each boiler for cleaning the evaporator helix between + 64 m and + 46 m. In the second step then another four Water Cannons were added to each boiler for cleaning the membrane walls in the burner area between +46 m and +17 m.

Design and functioning of Water Cannons

The general arrangement of the Water Cannon at the membrane wall and the design of the blower are shown in *Figure 1*. The sheet metal box on which the frame is mounted is fixed at the offset of the membrane wall. This serves for fixing and securing the Water Cannon at the membrane wall. As the frame is permanently attached to the membrane wall, the flexible water supply connection has to compensate the relative movement resulting between piping and Water

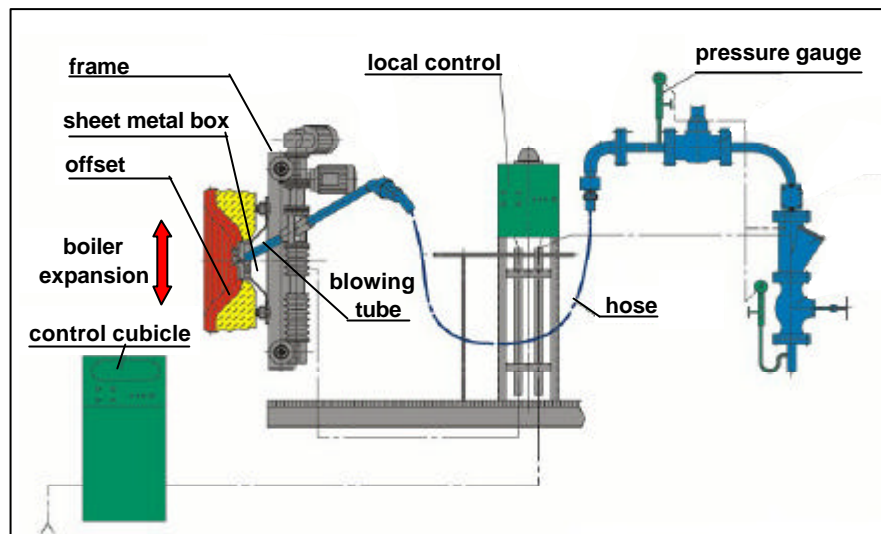


Figure 1. Attachment of Water Cannons to the membrane wall

Cannon due to boiler expansion. Through the various controllable guide rails the centrally arranged blowing tube can be moved into any position so that it is possible to run over the meander-shaped membrane wall.

As may be learned from *Figure 2*, four Water Cannons clean the opposite membrane wall with the water jet at each cleaning level. Here different blowing figures can be run. At the Weisweiler Power Station three blowing figures are successively run in meander form during each blowing process, membrane wall offsets such as flue gas recirculation heads, burnout air nozzles and burner mouths are left out. Thus, the whole evaporator helix is cleaned from +17 m to +64 m from the

two cleaning levels at +26 m and +54 m shown above.

The first heating surface bank delimits the area of action of the Water Cannons towards the vertically tubed membrane wall. This superheater heating surface should not come into contact with the water jet due to the high operating temperature and the related thermal shock risk.

Operating experiences at the Weisweiler Power Station

The important operating experiences acquired so far during cleaning of the furnace by means of Water Cannons have been listed below as sample points:

Cleaning effect

Fouling of the membrane walls largely consists of porous deposits. When the water impinges on these deposits, the water penetrates the pores and then is abruptly evaporated. As a result, the deposits flake off so that a very good cleaning effect is achieved.

Cleaning intervals

In view of this cleaning result the Water Cannons have to be operated only once a day

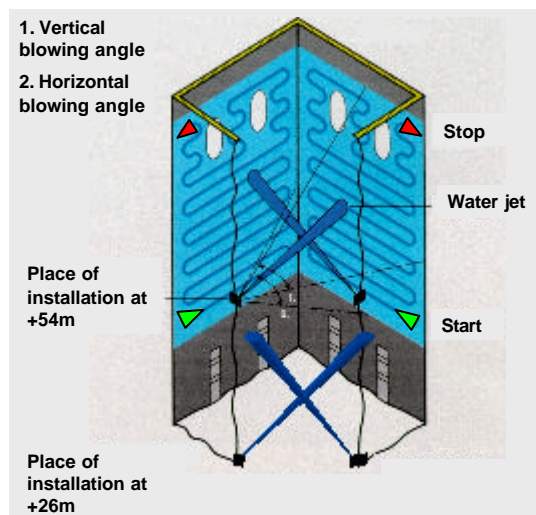


Figure 2. Cleaning by means of Water Cannons

while the present fuel still has potential for further reduction of the cleaning intervals.

Moreover, at the time of inspections additional cleaning of the membrane wall is not necessary.

Adjustment / Deflection of the water jet

The water jet and the resulting basic setting of the respective blowing figures are adjusted during the boiler downtime, first by means of laser and afterwards by the water jet. It becomes evident that, when compared with in-service cleaning, a deflection of the water jet of about 1 m is to be taken into account in the vertical direction. In the horizontal sense the safety distance is about 0.5 m, e.g. from the burner mouths. Boiler outages should be used to adjust the actual impact of the water jet on the membrane wall to the blowing program.

Setting of blowing figures

During cleaning of the membrane wall care shall be taken in order that the water jet does not run in parallel with the tube for, if so, the flow in the evaporator tube may be disturbed. Therefore, the water jet should always impinge vertically to the tube crown during cleaning.

Jet impact angle

Figure 3 shows the vertical swivel range of the installed Water Cannons. If the angle of the water jet which impinges on the membrane wall is too sharp, the cleaning effect decreases notably. Therefore, it is recommended to install four Water Cannons at each cleaning level, although theoretically only two blowers would be needed for cleaning the four membrane walls, due to the swivel range of the Water Cannons.

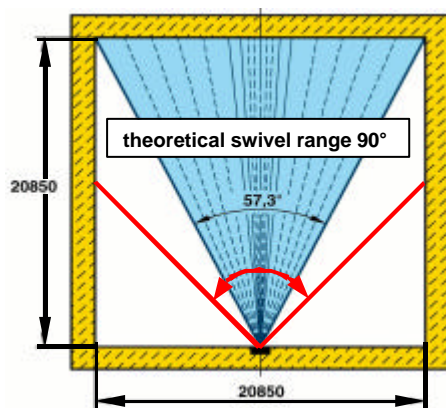


Figure 3. Swivel range of Water Cannons

Hose connection between blowing tube and water piping

The hose connection is necessary, on the one hand, to offset the relative movement between boiler and piping, on the other, to ensure free movement of the blowing tube. Damage was caused to the hose due to the temperature loading and the local installation conditions given. Therefore a different hose type was selected. If it is possible with regard to the installation conditions, the recommendations of the hose producer regarding bending radius, torsional strain, strain relief, etc., should be taken into account.

Slagging of flue gas recirculation shaft heads

An almost optimum heat absorption of the furnace is achieved through the very good cleaning effect of the Water Cannons. This leads to a reduction of the furnace end temperature which in turn reduces the slagging trend at the flue gas recirculation shaft heads.

Removal of old water blowers

Considering the good operating experiences with the WLB, the old water blowers were removed. In addition, the membrane wall offsets of the old water blowers in the area of maximum membrane wall stresses were closed reducing the number of boiler damage events.

Thermal recalculation

In the course of the years from 1987 to 1990 fouling of the membrane wall steadily increased. This altered fouling behaviour is attributable to the changeover to the low-NO_x operating mode and/or to the change of the fuel. To counter this, the number of water blowers in the furnace was increased from 64 to 116 units. Furthermore, complete cleaning of the evaporator helix became necessary during the inspections. With the installation of the Water Cannons the SK58 water blowers could stepwise be removed.

Figure 4 shows the assessment factors of the furnace and the radiation space

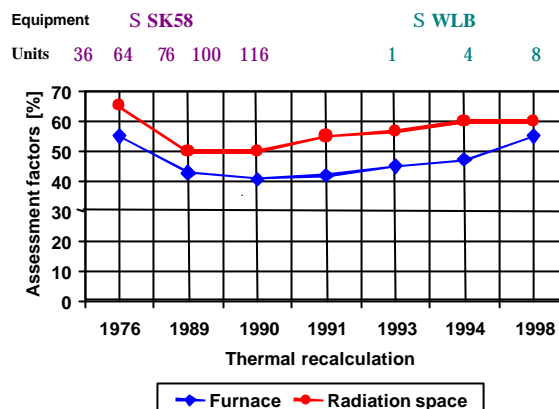


Figure 4. Assessment factors of furnace and radiation space

resulting from the thermal recalculation. It can be seen that 116 SK58 blowers are unable to keep the combustion chamber completely clean. An optimum cleaning result is only achieved through installation of eight Water Cannons. This good result is attributable, on the one hand, to the better cleaning effect of the Water Cannon and, on the other hand, to cleaning of the whole membrane wall area by the Water Cannon. At Weisweiler, besides the eight Water Cannons, only 16 SK 58 water blowers are still installed for cleaning the membrane wall in the area of the first superheater heating surface.

Temperature loading of membrane wall

Already before taking into service the first test Water Cannon RWE placed orders for investigations regarding thermal shock loading. The purpose of these investigations was to forecast the service life of the evaporator helix at the 1900 t/hr steam generator when cleaning the membrane wall by means of Water Cannons. As a result of these investigations special reference is made to the influence of the residence time of the water jet on the rate of life consumption of the evaporator wall. For a residence time of the water jet on the membrane wall of abt. 1 s and a frequency of WLB application of once per shift a life consumption of 50 % is reached after about 14 years of operation. For a residence time of abt. 1.5 s this value is reduced to 10 years of operation. At Weisweiler the Water Cannons are operated with a residence time of the water jet on the membrane wall of about 0.5 s.