OPERATION AND RESTORATION OF SINTERED FLAME-ARRESTING FILTERS OF DETONATION DEPOSITION PLANTS

V. A. Smirnov, I. I. Odokienko,
E. A. Astakhov, A. I. Zverev, Yu. F. Ocheret'ko,
V. I. Pashchenko, V. N. Kushnir, and S. I. Kaplyuk

In recent years there has been a considerable increase of interest in the technical potentialities of coating deposition by the detonation technique, mainly as a result of advances in deposition technology, manifesting themselves in the production of high-performance, heavy-duty automatic detonation plants [1, 2]. Up to now, however, stringent safety requirements have prevented this deposition process from being adopted by industry.

The most important element of a detonation deposition plant is the unit cutting off the supply of the gases (oxygen and acetylene) to the combustion chamber, where conditions favorable for their detonation are artificially created. Neither mechanical nor electrical nor nonreturn valves are capable of ensuring safe operation of such plants and use of water seals for the protection of the installation against backfiring sharply reduces their output.

To ensure safe operation (damping of the energy of combustion products in case of backfiring) of the detonation plants developed at the "Lenin Forge" Central Design Bureau, they are fitted with sintered filters. This solution was first proposed and tested at the Institute of Materials Science, Academy of Sciences of the Ukrainian SSR. Some of the sintered filters used for this purpose were made, by a process developed at the Special Design and Technology Bureau of the Institute of Materials Science, from electrolytic titanium powder in the form of disks of 15-mm thickness and 30-mm diameter. They had the following characteristics: air permeability at ΔP = 100 mm H₂O in the range 2.7-3.2 liters/min-cm² and maximum pore diameter d_max = 50μ.

A sintered filter is the key element of a flame arrester. In the simplest case a flame arrester is a partition inserted in a gas main, and which consists of a sintered filter fitted in a housing and sealed with PTFE washers. In the plant designed at the Special Design and Technology Bureau of the Institute of Materials Science such flame arresters are provided in all gas mains ahead of the mixer.

The plant developed at the "Lenin Forge" Central Design Bureau has its flame arrester mounted in the gas mixture main (behind the mixer). During the operation of the plant the combustible mixture from the mixer enters the flame arrester (Fig. 1), where it passes through the sintered filter 10, grid 2, and gauze 1, after which it flows through a spiral tube and a combustion chamber unit into the barrel of the installation. Backfiring can occur during the operation of this plant.

It has been noted by several authors [3, 4] that during detonation a flame is quenched under the same initial conditions as during deflagration. Extinction occurs as if a combustible mixture underwent no changes whatsoever on transition from deflagratory combustion to detonation. Of course, a detonation wave entering a flame arrester breaks down and the pressure falls to a value close to the initial, after which the usual mechanism of extinction of the resultant normal flame becomes operative [5]. The degeneration of the detonation wave into deflagration does not involve an appreciable time lag because it occurs over a comparatively short distance in sintered filters at a thickness as small as 5 mm [4].

Experience with the operation of the plant has shown that the flame arrester effectively protects the gas mains against occasional single backfirings. During backfiring the detonation wave loses part of its energy on entering the large chamber and passing through the gauze 1 and grid 2. The remaining part of the energy is damped during the passage of the wave through the sintered filter. Backfiring is likely to occur mainly during experiments with new coating application procedures and a result of spontaneous ignition of a combustible mix-
One of the most harmful effects of backfiring is a decrease in the air permeability of the sintered filter. After each backfiring the hydraulic resistance of the filter grows as a result of blockage of its pores by carbon black (product of acetylene combustion at a volumetric ratio $O_2 : C_2H_2 = 1 : 1$). When each gas main is fitted with its own flame arrester, the increase in the hydraulic resistance of each arrester is different, and consequently the composition of the combustible mixture changes. With a single flame arrester fitted in the gas mixture main (ahead of the combustion chamber unit), backfiring produces the same increase in the resistance of each main, so that the composition of the mixture does not change. In this case, in order to maintain the required rate of flow of the components of the combustible mixture it is necessary periodically to raise the operating pressure of the gases. As, however, on safety grounds in acetylene plants the pressure of the gas should not be allowed to exceed 1.5 atm [6], it only remains to replace blocked filters with new.

A blocked sintered filter can, of course, be restored. There are two possible ways of doing this:

1) by blow-back of gas under high pressure through the filter [1];
2) by subjecting the filter to treatment in an ultrasonic chamber.

With the filters under consideration, cleaning by blow-back of high-pressure gas proved unsuccessful because of the high adsorptivity of carbon black. For the same reason treatment of filters in an ultrasonic bath without the application of a static pressure failed to give the desired results.

In view of this, an attempt was made to restore sintered titanium filters in a UZVD-6 ultrasonic plant. In this plant, which operates under increased static pressure, it is possible to set up a very strong cavitation field. Vibrations of 18 kHz frequency were generated in the bath with the aid of PMS-15A18 ultrasonic magne-