NOTE ON THE FOULING OF UNDERGROUND REFRIGERATION CONDENSERS AND ITS PREVENTION BY CHLORINATION TREATMENT

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Rapid fouling of condenser tubes in underground refrigeration plants is a frequent occurrence. It leads to low heat transfer efficiencies, with consequent serious reduction in capacity and increase in the horse-power requirement of the units. High pressures develop in the condensers, and frequent cleaning of the tube bundles is required. The cleaning operation takes up to 8 hours and in some cases results in significant loss of production.

One of the possible causes of fouling is deposition of scale, but this can be readily overcome by controlling the concentration of the water.

When water evaporates, the dissolved solids remain behind; thus evaporation increases the amount of dissolved solids per unit volume. If half the original volume evaporates, the concentration of the dissolved solids is doubled and the water is said to have a 'concentration' of two. Concentration may be controlled by regulating the amount of water allowed to bleed from the system. The actual concentration value required is a function of the chemical analysis of the circulating cooling water.

In one instance, where the problem of scale formation had been eliminated, fouling still persisted, and the possibility of excessive quantities of dust in the re-circulating water was investigated. A dispersing reagent was added to the condenser cooling water as a means of preventing sludge deposition in the condenser tubes. As shown by curve A in Fig. 1 the reagent addition did not decrease the rate of fouling.

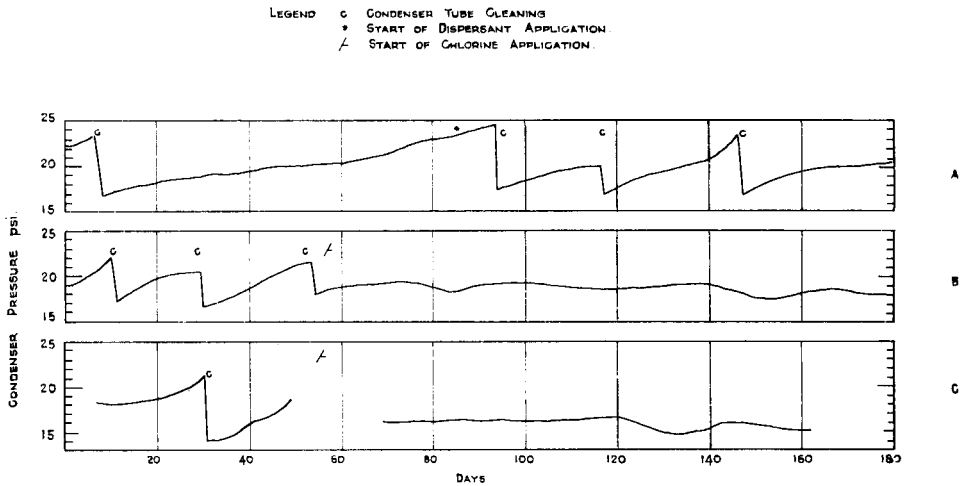

Fig. 1—The effect of (A) dispersants and (B and C) chlorine on condenser (refrigerant) pressures

The large amounts of sludge removed from the condenser tubes during cleaning indicated the possibility of fungal growth and a sample of the sludge from the refrigeration plant was submitted to The S.A. Institute for Medical Research, for identification.

Several species of fungi were identified which, as with fungi found in compressor cooling circuits, could be destroyed by chlorine. The fungal sludge found in the refrigeration plants appears as a brown-coloured rust-like deposit, while the sludge from the compressor coolers is a brown-black gelatinous substance which thrives on the tannin introduced to the water circuits to act as a corrosion and scaling inhibitor.

Using calcium hypochlorite (70 per cent available chlorine), shock chlorination was applied to the condenser cooling water. A 5 per cent solution was added to the recirculating pump suction once a day for a 10 minute period to give a residual free chlorine value of 10 p.p.m. in the water leaving the condenser tubes.

The tubes of the plant chosen for testing were not cleaned prior to chlorination, and chlorine consumption was such that it was necessary to introduce a concentration of 25 p.p.m. in order to obtain 10 p.p.m. in the exit water. The required initial concentration was reduced to 15 p.p.m. after two weeks and later to 10 p.p.m.

The effect of chlorination was immediate. Prior to chlorination the condenser refrigerant pressures increased at the rate of about 0·25 lb/in.^{2} per day as fouling progressed. Since application of chlorine started there has been practically no increase. Prior to chlorination the condenser tubes had to be cleaned at six-weekly intervals, whilst subsequent to its introduction (six months ago) no cleaning has been necessary. Curve B illustrates the degree of success obtained.

As soon as it was proved that the chlorine had the desired effect, the treatment was applied at other installations, and curve C represents a typical condenser pressure curve obtained.

The output of one of the refrigeration units was calculated and was found to have increased from 430 ice-tons before chlorination to 470 ice-tons after treatment commenced.

The rate of corrosion of the ferrous metals in an air compressor heat-exchanger shell subjected to shock chlorination has been found to be approximately 0·003-0·004 in. per year—but less than 0·001 in. per year for brass. Similar tests are being conducted to study the rate of corrosion caused by the daily application of chlorine to a refrigeration condenser.

Visual inspection of the condenser tubes after three months of chlorination revealed that no fungal growth was occurring, but a very thin layer of light-grey coloured deposit was evident. The deposit was not impairing heat transfer efficiency at the end of three months, but tests are being conducted to evaluate the advantage of keeping the tubes completely clean.

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