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BERKELEY CYCLOTRON OIL DIFFICULTIES

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February 14, 1952

Berkeley, California

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The difficulty encountered with the magnet coils of the 184-inch cyclotron at Berkeley, California might be of interest to others, that also operate oil cooled machines. The trouble showed up as a progressive heating of the lower coil tank during the past two years. An investigation into the problem indicated that the difficulty must be at the heat exchanger which is used to cool the oil. Consequently the heat exchanger was dismantled and a green viscous material was found deposited on the inside surfaces. This material was approximately one-eighth of an inch in thickness and prevented proper heat flow through the walls of the cooling tubes. Further investigation disclosed large amounts of this green material in the bottom of the lower coil tank.

Analysis of this green material was made by California Research Corporation, a research subsidiary of Standard Oil Company of California. The analysis showed that the material was an organic copper compound (a copper soap) usually formed by oil derived acids attacking the copper. These acids are usually formed by oxidation of the cooling oil in the presence of copper and moisture which act as catalysts. The resulting soap is in itself a powerful catalyst for the further oxidation of the oil.

The lower coil system was cleaned by an industrial company whose specialty is cleaning large systems and particularly those in oil refineries. This was done by filling the lower coil system with a combination of suitable organic solvents, and allowing it to stand for twenty-four hours.

After the system had been cleaned, it was filled with Wemco-CI oil, which has inhibitors in it to destroy the catalytic action of copper in oxidizing the oil. Although no single characteristic of the oil can be used as a criterion for discarding the oil, the recommendation was that if the oil acidity reached a neutralization number of 0.3 (number of milligrams of koit to neutralize the acidity in one gram of oil), the situation could become dangerous. In addition they recommended that moisture be kept out of the oil by forcing dry air over the surface of the oil in the coil tanks. The best solution is to have a sealed system which can be kept under dry nitrogen but this is not possible at the Berkeley cyclotron.

These oxidation reactions are accelerated at elevated temperatures and for this and other reasons the operating temperatures should be kept low. The start of this reaction at Berkeley was no doubt at the time of the fire that occured on the bottom of the lower coil tank in 1946. At that time, although the main body of oil did not get hot, there probably was local intense heating at the spot of the fire that started the reaction. However the oil companies state that these oxidation reactions take place at temperatures that are easily reached by normal operation and that the acidity in particular should be carefully watched.

The magnet at Berkeley has a total of 300 tons of copper in the coils and requires about 750 kilowatts for its excitation. Each of the two coil tanks used about 3500 gallons of oil in its cooling system and has never been operated with an oil temperature in excess of 55 degrees centigrade.