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Dr. Calvin - for your information.
7/29/42. E.P.Stevenson.

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Memo to Roger Adams

from

Roger Williams

OXYGEN FROM AIR VIA SALCOMINE

Oil-Suspension Process

In the Ammonia Department's work on the use of Salcomine for the extraction of oxygen from air, it has been found (1) that Salcomine can be suspended in white oil, (2) that this oil is inert to Salcomine, (3) that the same amount of oxygen is taken up by the suspended material as by the dry material under the same conditions, (4) that oxygen is absorbed about as rapidly by the suspended material as by the dry material under the same conditions, (5) that the oxygen taken up can be evolved as readily from the suspended material as from the dry material under the same conditions, and (6) that the absorption-desorption cycle can be repeated over and over again, with no diminution in the activity of the suspended Salcomine to date. The development of a process based on the use of such a suspension, for application in stationary or mobile units of large or small capacity, is well under way.

Attention to the suspension process has naturally arisen from consideration of certain advantages which it has over processes using the dry material. A first and primary advantage is related to the chemistry of the process. The reaction of oxygen with Salcomine is highly exothermic and if the heat of reaction is not removed as and where it is developed, the temperature becomes so high that the organic part of the Salcomine complex is oxidized and the material is destroyed for further use in oxygen absorption. In the dry process, the material must be so disposed that the heat of reaction can be withdrawn through very nearby cooling surfaces. But even so, there is danger that particles farthest removed from these surfaces may become overheated and a portion of the material thereby be destroyed. Even if this is avoided, we know from experience with catalysts in active exothermic reactions like the Salcomine oxidation, that grave damage can result from overheating so local that it cannot be detected except by its effect on catalyst activity.

In the suspension process, oil, the suspending medium, is in intimate contact with each particle of Salcomine and absorbs the heat of reaction as and where it is evolved. Heat capacity-concentration relationships are such that even at full saturation of the Salcomine with oxygen, the temperature rise of the suspension (10° C.) is so small that the temperature reached is far below that detrimental to the structure of the oxygen-saturated Salcomine. Accordingly, the oil protects the

Salcomine against deterioration in use. From such experiments as we have been able to carry out to test the point, it appears that the suspension presents less fire and explosion hazard than dry Salcomine.

Other advantages of the suspension process over the dry process pertain to engineering application. In the dry process, carried out batchwise, the vessel containing the Salcomine is subjected to a cycle of operations: (1) building-up of air pressure, (2) absorption, with simultaneous cooling, (3) release of pressure, (4) purging of residual air, e.g. by pulling vacuum on the vessel, (5) heating to desorption temperature, (6) desorption, with continued heating, (7) cooling to absorption temperature. For steady production of oxygen, several vessels are needed and the synchronized control of the cyclical operation of each and all of them leads to the necessity for providing multiple controls which are likely to get out of order. Furthermore, the process has the usual defects inherent in batch operation--constantly changing conditions, poor unilization of heat transfer surface, etc. Also, unless a fluctuating load on the air compressor can be avoided, this is certain to cause rapid failure in any light machine suitable for mobile units.

The suspension process is designed for continuous operation. Each part of the unit has a single duty and conditions can be maintained steady in it. The principal equipment items in series are: (1) an absorber, to which compressed air and de-oxygenated suspension are supplied; (2) a release vessel for vacuum evolution of nitrogen dissolved in the oil; (3) a heater for bringing the suspension to desorption temperature; (4) a desorber, to furnish time for the evolution of oxygen; (5) a cooler, to lower the temperature of the suspension into the absorber. Control of conditions throughout the system is simple, easy, and reliable and very likely can be made altogether automatic with a few standard devices not in the gadget class. Conversations with manufacturers indicate that air compressors which will give good service under the steady conditions to be maintained are readily available in standard models and can be delivered in short times.

The use of a suspension does require the use of an added material--oil--which does have weight, and it is of course important that the weight of the whole assembly be as small as possible. However, it appears that a reduction in the weight of equipment as compared to that required for the dry process will more than compensate for the weight of the oil.

Work at the Experimental Station has progressed to the point where the erection of a small demonstration unit is the next logical step in the development program, and this is being undertaken. A mobile unit, to be mounted on a trailer and to deliver 1,000 cubic feet per hour of oxygen, can soon be designed, we believe. We have "background" for such a unit from experience gained in the successful design of a trailer hydrogen unit for the Bureau of Aeronautics, Navy Department. A number of such units are now under construction at our Belle Plant. In designing the hydrogen unit, we learned how rugged and "foolproof" such a process and its equipment must be for field service in the hands of non-technical personnel. We are attempting to keep sturdiness and simplicity uppermost in developing the Salcomine suspension process.