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Aluminum Nitride

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A paper on aluminum nitride and the Serpek process, by Dr. **Jos. W. Richards,** of Lehigh University, was the first paper of Thursday afternoon. It was essentially the same paper as presented by the author before the New York section of the American Electrochemical Society and published in full in our March issue, page 137.

New, however, were the following notes on the Serpek reaction.

The decomposition of alumina by carbon in presence of nitrogen to form aluminium nitride is a reaction which is interesting to study and compare with analogous reactions.

Professor Baron, in 1760, tried to reduce alumina by carbon, but was unable to obtain the temperature required.

Oerstedt, in 1817, devised a way to decompose alumina by carbon, finding that this took place in a stream of chlorine gas, at a low temperature, the products being aluminium chloride and carbon monoxide gas.

$$Al_2O_3 + 3C + 3Cl_2 = 2AlCl_3 + 3CO.$$

This reaction is practically the exact analogue of the Serpek reaction, using chlorine instead of nitrogen. Deville, for instance, who ran this operation on a large scale, remarks that the retort is heated to a uniform dark-red heat (which would be about 600 deg. C.) and that "however fast the chlorine may pass into the retort, it is so well absorbed during three-fourths of the operation that not a trace is mixed with the carbon monoxide escaping."

If the query be made as to why the reaction is so easy, thermochemistry gives us the answer: the reaction is exothermic 17,880 calories.

$$Al_2O_3 + 3C + 3Cl_2 = 2AlCl_3 + 3CO.$$
$$-391{,}600 \qquad +322{,}000 + 87{,}480 = +17{,}880$$

It is profitable to consider in this connection another analogous reaction.

$$Al_2O_3 + 3C + 3S = Al_2S_3 + 3CO.$$

This reaction does not take place at 1200 deg. C., and we find it would be endothermic (heat absorbing) 180,200 calories. However, the reaction with carbon and sulphur already combined as CS_2 does take place, readily, at 1000 deg. C., and this reaction is much less endothermic than with C and S separately:

$$Al_2O_3 + 3CS_2 = Al_2S_3 + 3COS$$
$$-391{,}600 + 87{,}000 + 124{,}400 + 111{,}090 = -69{,}110$$

Coming now to the nitrogen reaction, we have:

$$Al_2O_3 + 3C + N_2 = 2AlN + 3CO$$
$$-391{,}600 \qquad +90{,}900^* + 87{,}480 = -213{,}220.$$

The figure 90,900 was given as provisional. It is not a measured value.

The above is therefore a highly endothermic reaction and corresponding with that we have the fact that it does not take place to an appreciable extent below 1500 deg. C. Aside from all thermal losses, we can say, therefore, that the reaction itself absorbs 213,220 calories = 248 kw-hours for 82 kg. of aluminium nitride formed; which equals 3000 kw-hours = about 1/3 kw-year per ton of nitride. At least double this amount would be required in practice.