

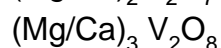
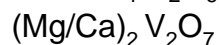
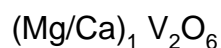
RB-26 CORROSION IN THE GAS CIRCUITS DUE TO VANADIUM COMPOUNDS

Vanadium forms several oxides such as V_2O_2 , V_2O_3 , V_2O_4 and V_2O_5 . The acid nature raises the degree of oxidation, V_2O_5 (pentoxide) has the most acidic nature and is therefore the most corrosive. On the other hand, under combustion conditions where large amounts of O_2 and high temperatures exist, any form of vanadium present in the fuel oil will have a tendency to be oxidised into V_2O_5 , therefore, its presence will be certain in the combustion gases and in a liquid state (established at $690^\circ C$) where two very harmful effects originate:

- Catalysis of the oxidation of $S O_2$ to SO_3 .
- Corrosion of the metal surfaces to form ferric meta-vanadates ($Fe(VO_3)_3$).

As other metals are also present in the fuel oil (see chapters 2 and 3), part of the V_2O_5 has a tendency, by its reactivity, to form salts (vanadates) with the alkaline metals and alkaline-earth.

The alkaline-earth vanadates have a high fusion point, $1000^\circ - 1200^\circ C$, therefore as a rule, after combustion it is found in a solid state, in the form of a powder which is carried by the gases. In this type of salt we find the calcium vanadates and magnesium vanadates:



The alkaline vanadates, mainly the distinct sodium vanadates have a much lower fusion point (350° to $650^\circ C$), and are therefore found in a wide zone of the waste gases circuit in liquid state. These vanadates are very reactive with the iron and iron oxides, dissolving them to form vanadates or double sulphovanadates, above all in the presence of sodium sulphate.

The fusion temperature of the different sodium vanadates that can be formed comes from data of the molecular weight relation V_2O_5/Na_2O , according to the following table:

| <u>Rel. V_2O_5/Na_2O</u> | <u>Fussion Temp. °C</u> |
|---------------------------------------|-------------------------|
| 0 | 400 |
| 1 | 550 |
| 2 | 450 |
| 3 | 350 |
| 4 | 530 |
| 6 | 580 |
| 8 | 620 |
| 10 | 640 |
| ∞ | 690 |

We see therefore, that in the waste gases circuit, there exists a great probability of finding sodium vanadate in a liquid state, corrosive, above all when the molar relation V_2O_5/Na_2O is 3. Nevertheless, though such relation will be higher or lower in a combustion installation of the engine boiler type or, there are many important areas of metal parts subjected to greater temperatures greater than 690° C, therefore the corrosive effects of the alkaline vanadates are practically guaranteed.

At this point, the question is: if the fuel oil contains impurities of S, V and Na, is the formation of corrosive sodium sulphate and sodium vanadate unavoidable? Certainly, unless correction factors are introduced into the process. These factors should perform two requirements to avoid or minimise these types of corrosion.

- a) as N is basically found dissolved in the water of the fueloil, this must be separated at the bottom by decantation, centrifuge, etc. so that the N sent to the combustion will be much less.
- b) since Vanadium is found in the fueloil in soluble form and it is not possible to separate it by decantation or centrifugation, the rapid formation of alkaline-earth vanadates (Ca, Mg) is favourable in the combustion for two purposes:
 - b-1) to avoid the catalytic action of the V_2O_5 on the reaction of

$$SO_2 + \frac{1}{2} O_2 \text{ -----} > SO_3$$
 - b-2) to raise the fusion temperature of the vanadates so that they will be carried in the form of powder.

Note: You can complete the information provided in this report, in the document [RB-7 Fuel oil and its corrosive effects in industrial combustion.](#)