CARBOTHERMIC REDUCTION OF ALUMINIUM AND SILICON OXIDE MIXTURE

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After secondary aluminium production appears oxide residue which contains mostly aluminium and silicon oxides. Nowadays, there are no opportunities to extract these metals and slag is mainly used in building industry. Such as more than half of aluminium is applied for AlSi-based cast alloys, carbothermic reduction becomes perspective direction in metallurgy. There are clear advantages of carbothermic reduction: high productivity, lover energy consumption, environmental issues.

Lots of investigations were carried out to develop carbotermic reduction of aluminium oxide, but up to now there are no metallurgical processes were accomplished to produce metallic aluninium. The reactions for reduction of Al2O3 and SiO2 to produce Al or an AlSi alloy are very complex, because numerous components are formed and react during the process.

The required reduction temperature of aluminium oxide varies between 2100^{0}C and 23000C and the process runs in two steps.

1. step:2Al2O2+9C=Al_4C3+6CO(1950-2050 ^{0}C) (1)

2.step:Al4C3+AL2O3 =6AL+3CO(>20500C) (2)

Total AL2O3+3C=6Al +3CO (3)

The main problem of the process is solubility of aluminium carbides and oxides. They are formed during the process, dissolve in AL and must be separated.

The first carbothermic reduction of aluminium ores for the production of AlSi alloys was cared out By Lurgi-Thermie in Germany 1925 until the beginning of the Second World War and then was abandoned. In spite of continuing research work in the United States the process couldn't gain the commercial acceptance except for Zaporoschje, Ukraine. The advantages of this process is the prevention of the aforementioned solubility of aluminium carbides and oxides in AL. This can be prevented by adding oxides (for instance SiO2), which causes a decomposition of the carbides.

The reactions of the process run in three steps:

1.3SiO_2+9C=3SiC+$_6$CO (1500-1600^{0}C) (4)
2.Al_2O3 +3C= Al_4O_4C+$_2$CO (1600-1900^{0}C) (5)
3.Al_2O3+3SiC=4Al+Si+CO(1950-2200^{0}C) (6)

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Thermochemical Calculation

The goal of thermochemical calculation is to understand how SiO2 influence the reduction process. As described in the previous chapter winning of aluminum by direct carbotermic reduction is very difficult unless impossible. The addition of SiO_2 can reduce the formation of carbides. The higher the amount of silicon in the alloy the lower is the formation of carbides. However, the silicon amount in the allyshould be as low as possible considering of the late use of the alloy. We took the range of temperature between 1500 and 2400C°. The amount of carbon is stoichiometrically relative to the amount of oxides. Calculations were done for AlSi35

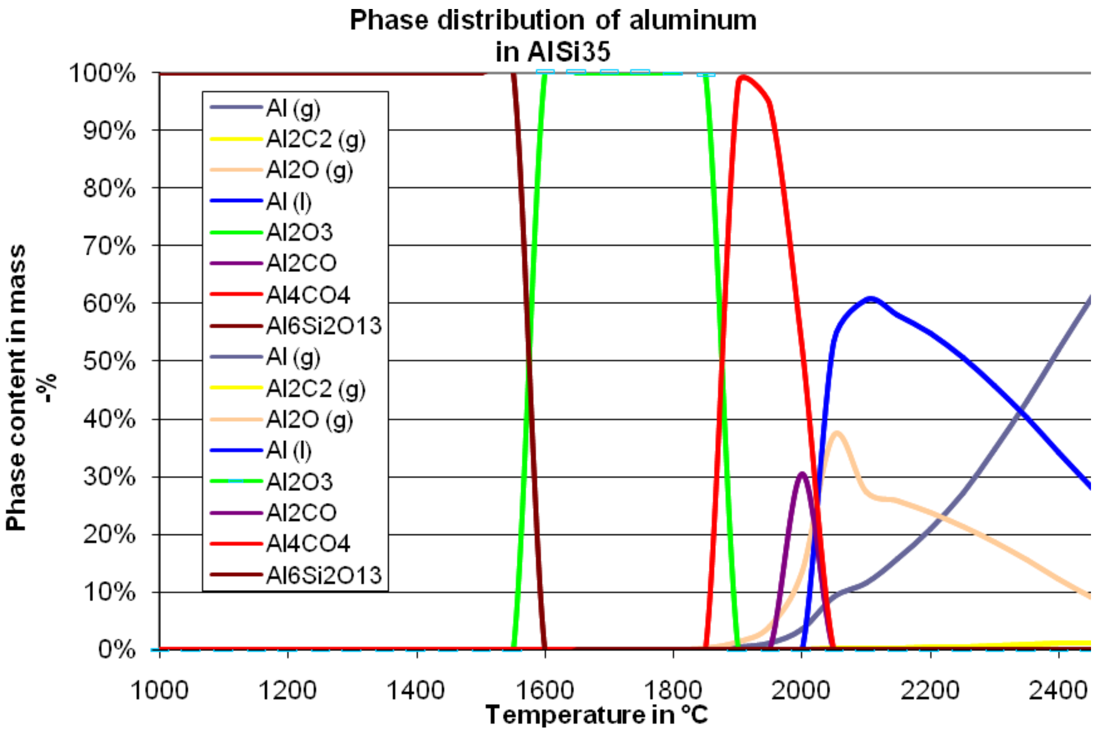

Figure 1 – Distribution of Al at the production of AlSi35

From the figure 1 we see that the amount of Al4CO4 starts to decrease rapidly from the point of $1900C^0$ and after $2050C^0$ it is substituted by increasing of pour aluminum content. The highest amount of aluminum appears approximately at temperature 2100C°. Increasing temperature we louse pure aluminum through the gas phase. Thus, it is clear that 2100C° is optimal temperature for this process.

After modeling of this process it is designed to conduct trials in Taman furnace. Oxide residue will be mixed with additions of sent for reaching the desirable ratio AlSi35 and binder. Then the mixture will be pelletized.