CHANGE OF CASTING MATERIAL REDUCES ENVIRONMENT POLLUTION
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Introduction

After passing the world energy crisis in seventies, most of the countries are interested in reduction of energy consumption in manufacturing. One of the reasons is that the electric power industry significantly pollutes the environment. In particular, the power industry based on the coal-type materials is the main source of the atmosphere pollution due to large volumes of carbon, sulfur and nitrogen oxides produced. Compared to other countries, Polish industry is much energy-consuming (see Fig. 1 and 2) and it is in over 70% based on the coal. It can be confirmed by the summary of the main air pollutants, shown in Fig.3 where their total volumes are split into the following four sources: public power plants, non-public power plants, manufacturing and others.

It seems to be necessary to reduce the energy-consumption in the critical areas, e.g. foundry industry. The energy-consumption of foundry manufacturing processes can be diminished by reduction of the casting weight, change of its shape or changing the process. The aim of the present work is an analysis of the energy consumption in manufacturing, based on the example of pipe fitting castings, currently made of white malleable cast iron.

Methodology for calculation of energy-consumption in manufacturing

Practical calculations of energy-consumption in manufacturing take into account the following three components of the energy:

- cumulated input energy of the materials used for manufacturing
- cumulated input energy of the tooling
- cumulated input energy of the manpower

The calculations are performed, by splitting the whole process into phases. In case of sand castings the phases are: designing, mold preparation, metal melting and pouring, knock-out of the casting, finishing, heat treatment and final check.

The values obtained in that type of computations, are the primary energy inputs. In case of the electric energy component, it means that one must take into account the fuel
combustion energy, necessary for the electric energy production. Currently the appropriate energy acquirement coefficient value in Poland is 9.3 MJ per kWh of electric energy [5].

Comparison of energy-consumption in manufacturing malleable and ductile cast iron castings

The calculations were based on the workshop data collected in one of the Polish foundries and on the author's computations published in [4]. The main difference between the energy-consumption for the currently used casting material (malleable cast iron) and the alternative one (ductile cast iron) results from the differences in their heat treatments, shown schematically in Figs. 4 and 5, respectively.

The computed saving of electric energy due to the change of the casting material is 1.77 kWh per kg of the casting. However, to determine the overall energy effect, the above value must be multiplied by the energy acquirement coefficient given in the previous section. This gives the following values of the total energy inputs:

- for malleable cast iron castings = 66.15 MJ/kg
- for ductile cast iron castings = 55.6 MJ/kg

The above values also permit an estimation of the reductions of the main air pollutants emissions, based on the date similar to that shown in Fig. 3. The resulting values for a year production of 5000 MG (tons) are: \( \text{CO}_2 \rightarrow 9700 \text{ Mg}, \text{SO}_2 \rightarrow 68.4 \text{ Mg}, \text{NO}_2 \rightarrow 28.5 \text{ Mg}, \text{dusts} \rightarrow 57.8 \text{ Mg}. \) The volume of the waste materials will be reduced by approximately 3800 Mg (tons) per year.

Conclusion

An important factor in making decisions about changes in casting processes is the tendency toward reduction of energy-consumption. For the case studied, the replacement of malleable cast iron by ductile cast iron gives about 16% reduction of the energy consumption. This should result in significant reduction of the environment pollution.

References