Role of Automotive Industry in Global Warming

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Abstract. Global warming and air pollution by human made gases such as CO₂, is mainly produced by automotive industry that results in great risk for human health. The aim of this study is to reduce the above problem by using the high strength materials with low density in the manufacturing of automotive vehicles. An approach applied here is to enhance the strength by reducing the grain size, lowering the density and increasing elongation. Four steel samples with different chemical compositions were selected. Samples were heat treated from 850 °C to 1250 °C and cooled in water. Grain size distribution was calculated using matrox inspector software and result was plotted using origin. It was found that 850 °C has lowest and 1250 °C has highest grain sizes. Strength of steel can be increased not only by adding the alloying elements but also by controlling grain size. Light weight material consumes lower fuel and emits lower CO₂, thus it minimizes the global warming and air pollution.

Keywords: global warming, CO₂ emission, light weight, low fuel consumption, grain size.

Introduction

The automotive industry has increased the weight of cars due to increasing people’s luxury and safety which leads to consume higher energy in the form of fuel and obviously increasing the global warming and air pollution (Ángel et al., 2017). Due to these effects the temperature of earth can further increase in the coming years. The share of automotive industry in global warming in the form of CO₂ is roughly about 17% (Afnan et al., 2017). Since last twenty five years competition among the safe, light, and more fuel economic land vehicles demand has significantly increased to high level (Alidad et al., 2018). In this challenging task of achieving significant reduction in global warming and fuel economy, many researchers investigate the TRIP and TWIP steels (Johnsan et al., 2017). Strength to weight ratio is a hot issue for the steel researchers. The usual trend to decrease the sheet thickness ratio and increasing the strength, researchers increase the amount of manganese, however Mn is considered to be little bit expensive (Kuimov et al., 2016). Therefore, there is a strong driving force for steel makers to design and develop a microstructure and grain size of the steel to achieve high strength, high hardness and low density of the steel structure (Jian Chai et al., 2016). The components of automotive cars and the whole body of the passenger vehicles can reduce total weight of the vehicles (Jinwon et al., 2016), consequently it can reduce the fuel consumption and reduction in fuel automatically reduces the CO₂ emission in the air thus reducing the global warming effect in Pakistan.

Materials and Methods

Four steel samples were made six in numbers to investigate the effect of grain size on the strength properties and subjected to heat treatment. Each specimen was soaked at the specific temperatures for the time periods as shown in Fig. 1. After heat treatment samples were rapidly cooled in tape water. Samples were cut in perpendicular direction at the rolling plane and were brought to basic metallographic investigation by using grinding followed by polishing. The polishing agent was the diamond paste made from alumina.

Heat treatments were followed by metallography and microscopy to reveal the changes due to micro alloy addition and their resulting precipitation. By resulting
Fig. 1. Heat treatment cycles to be followed.

Fig. 2. Tensile samples of the steel.

microstructure and using the software matrox inspector the GSD (Grain Size Distribution) histograms and sizes were obtained (Nicholas et al., 2016) as shown in the Figure 3-6. Two steel samples as shown in Fig. 2 were prepared for tensile testing to know the effect of grain size in each.

Results and Discussion

Firstly samples of the steel under investigation in this research work were treated with heat at 1250 °C followed by water quenching. All the four steel samples were observed under different soaking temperatures with fixed time of 60 min each. Microstructure preparation was carried out by using conventional metallography and etching technique with 2% Nital solution. After revealing the structure each sample’s grain size distribution was calculated using latest metrox inspector software (Qi Zhang et al., 2018). Higher strength was achieved at lower heat treatment temperature and it was the indication that not only by alloying elements can increase the strength of steel used for automotive parts manufacturing but combination of heat treatment parameters can also increase the strength property (Ralf et al., 2017). This conceptual skill can be utilized to adopt strength to weight ratio of the automotive steels thus it is not only the cost effective but will minimize the weight of passenger vehicles without scarifying of strength (Shahid et al., 2018). The heat treatments of the four samples are shown in Fig. 3-6 along with their grain size distribution. Each experiment is performed to investigate that which steel sample has high strength properties because the steel material is widely used for car bodies and other small machine components which increases the overall weight of the land vehicle that consume high energy fuel. By utilizing the lightweight materials during manufacturing in the plant may minimize this problem. It is always the trend to use the high alloyed steels to obtain the high strength. But this not only increase the cost but also the weight of the steel itself.

Figures 3-6 indicates the grain sizes of the experimental steel with respect to holding time and temperature in the heat treatment furnace. In Fig. 3 the mean grain size $D_0$ of the experimental steel is 12.19 μm at a temperature of 850 °C and the mean grain size increases by increasing the temperature i.e., $D_0$ is 40.03 μm at 1250 °C. By following the same methodology in Fig. 4-6 mean grain sizes increase with increasing temperature. To achieve the higher strength grain size of the steel should be low because finer grain size materials may exhibit higher strength with low weight (Bhagat et al., 2018; and Martin et al., 2008). Reduction in grain size may also increase in the tensile strength by applying high yield stress and lower elongation as shown in Fig. 7 (Chandrashekar et al., 2009).

The high percentage of elongation is possible with higher grain size at lower yield stress as indicated by the tensile testing results, shown in Fig. 8 (The testing
samples of both conditions have been shown in Fig. 2). It means higher strength to weight ratio is achievable in the experimental steel under investigation having fine grain size. Majority of automotive components are made from ferrous material like steel so there is a strong driving force for steel manufacturers to decrease the
density of steel (Lin et al. 2018; Shan et al., 2018; Xiaoxin et al., 2017). Tensile testing results show that finer grain size sample has higher elongation rate comparing with coarse grain size.

**Conclusion**

This study was carried to observe the effect of grain size control and resultant microstructure on the grain size distribution and % elongation on the strength of the experimental steel used for automotive industry. Its effect on air pollution and global warming in Pakistan has also been studied using heat treatment design and tensile testing machine available locally. It was found that there is a strong relation between grain size and strength. Strength can be increased by decreasing the mean grain size of the experimental steel which can be used in automotive industry for making different functional parts of the land vehicles and reduce the overall weight by scarifying the higher number of alloying elements. In this way low energy will be consumed in the form of gasoline and emission of CO₂ gases in the environment will be lesser in quantity and diminish the global warming produced by the vehicles.

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**Conflict of Interest.** The authors declare no conflict of interest

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