

**LCA METHOD AS AN USEFUL TOOL IN PRODUCTION
ENGINEERING**

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ABSTRACT

The most used and established method for detecting the effects of the product on the environment is a life cycle assessment (LCA) method.

LCA analyzes the effects of the product on the environment in its all five life stages: design, materials selection, manufacture, use, and ultimately its removal. At the same time LCA is an important tool when we deciding on choosing and optimizing the technology and raw materials.

In the frame of our study is discussed LCA method as an useful tool in production engineering praxis. The application of LCA for the Slovenian steel producers and automotive industry was analyzed.

During the first pilot project heavy plates of typical steel grades from ACRONI production program were discussed, and in the frame of the second project a new generation of supercharger housing for gasoline engine AUDI 3.0 was analysed.

1. INTRODUCTION

Steel touches every aspect of our lives. No other material has the same unique combination of strength, formability and versatility. Steel is a perfect and everlasting material, unlimited in its practicality and possibility for upgrading. It is the only material which can be recycled to one hundred per cent. Due to its versatile applicability it is a reliable partner in various fields, such as construction, mechanical engineering, automotive industry, ship-building, production of pipes, home appliances and so on [1].

The variety of advantages of steel products range from technical, such as material strength and high production technology, economical as steel ensures quick and easy construction, fast assembly and fast installation, to advantages as regards safety as it enables low weight and anti-seismic construction. Due to its aesthetic advantages it is also often used for thin and light construction, and is cherished for its simplicity. The possibility of recycling steel to 100 % also presents a significant environmental advantage (Figure 1) [2].

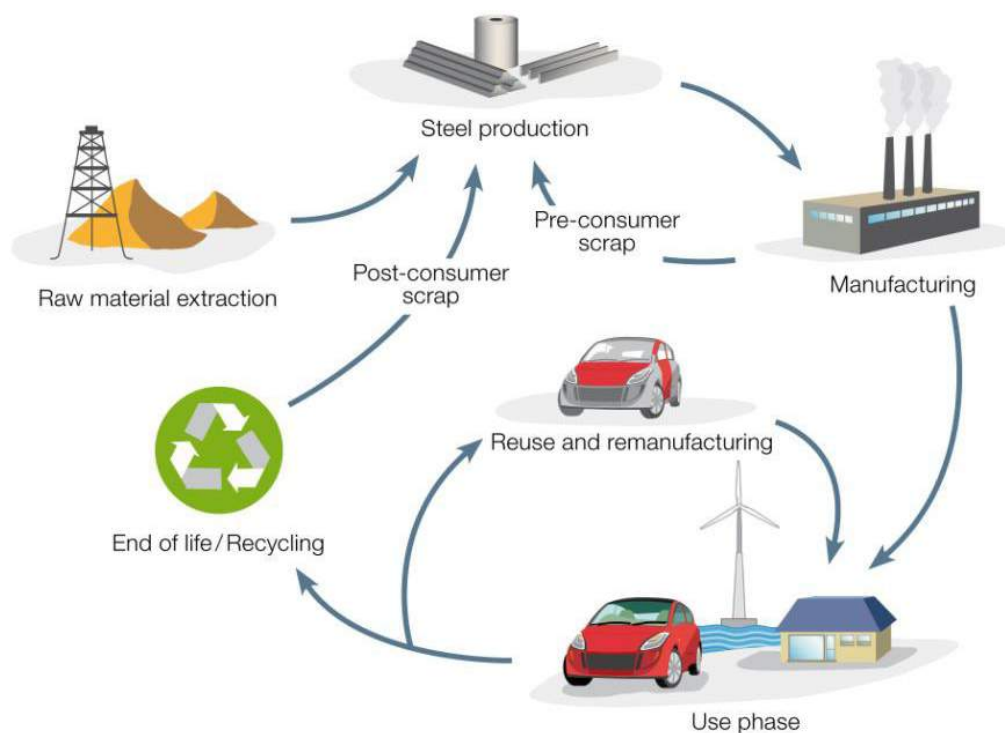


Figure 1. The life cycle of steel [2].

The amount of energy required to produce a 1 tonne of steel has been reduced by 50% in the last 30 years. All steel created as long as 150 years ago can be recycled today and used in new products and applications. By sector, global steel recovery rates for recycling are estimated at 85 % for construction, 85 % for automotive, 90 % for machinery and 50 % for electrical and domestic appliances. Leading to a global weighted average of over 70 %. Nowadays, 97 % of steel by products can be reused [2,3].

Table 1. World steel production for the period 2005-2014 (in thousand tonnes) [3]

Steel production Year	World	EU	Slovenia	B & H	China
2005	1.147.805	195.608	583	289	355.790
2006	1.250.107	207.306	628	490	421.024
2007	1.348.122	210.185	638	533	489.712
2008	1.343.269	198.616	642	608	512.339
2009	1.238.285	139.393	430	519	577.070
2010	1.432.761	172.816	606	592	638.743
2011	1.537.206	177.717	648	649	701.968
2012	1.559.472	168.580	632	700	731.040
2013	1.649.303	166.356	618	722	821.990
2014	1.670.145	169.301	615	793	822.698

In the 1970s and 1980s, modern steel plants needed an average of 144 kg of raw materials to produce 100 kg of steel. With investments in research, technology improvements and good planning, the steel industry today uses only 115 kg of inputs to make 100 kg of steel – a 21% reduction. Steel is a key driver of the world’s economy. World crude steel production: From 28.300 thousand tonnes in 1900 to 851.000 in 2001 to 1.537.000 thousand tonnes in 2011. The World production of steel in year 2014 was 1.670.145 thousand tonnes, in EU 169.301 thousand tonnes (production stagnated), and in China 822.698 thousand tonnes. For example: average Slovenian steel production in last 10 years is approximately 610.000 tonnes per year. World steel industry directly employs 2 million people worldwide, with a further 2 million contractors and 4 million in supporting industries. As key product supplier to industries such as automotive, construction, transport, power and machine goods, steel industry has employment multiplier of 25:1. Steel industry is at the source of employment for more than 50 million people. World average steel use per capita has steadily increased from 150 kg in 2001 to 220 kg in 2010 [2,3].

Today global steel producers give increased emphasis on protecting the environment and deploy into production and supporting the activities of the so-called concept of sustainable development, which is reflected particularly in the implementation of environmental management systems [4,5].

Under green economy steel industry has to be sustainable on three levels:

- Financially sustainable,
- Environmentally sustainable, and
- Socially sustainable.

The most used and established method for detecting the effects of the product on the environment is a method of life cycle assessment (LCA), which analyzes the effects of the product on the environment in all its life stages (design, materials selection, manufacture, use, and ultimately its removal), and is an important tool when we deciding on choosing and optimizing the technology and raw materials [6-8].

2. SLOVENIAN STEEL PRODUCTION

The biggest owner of the Slovenian Steel Group (SIJ) and at the same time of the Slovenian steel industry is Russian company KOKS (which is majority owned by the Zubitskiy family). On March 7th 2016, the parent company SIJ had the ownership presented in Table 2. [9].

Table 2. Shareholders [9]

Shareholders	No.of shares	% of ownership
OAOKOKS	718.351	71.2239
Republic of Slovenia	248.655	25.0001
D.P.R. d.d.	11.468	1.1530
Others	16.142	1.6230

The SIJ (Slovenian Steel Group) is one of the largest business groups in Slovenia according to both income and the number of employees, and such is one of the key elements of Slovenian economic development. The biggest steel producer (steelwork) in this group is ACRONI). The production range of Slovenian Steel Group (and ACRONI), comprises products of a flat and long steel program and forgings made of high quality steel in an electric arc furnace and vacuum metallurgy processes with a high processing rate. The steels grades produced can be divided into 5 basic groups: stainless steel, tool and high-speed steel, electrical sheets, structural steel, and other special steel [9].

Acroni is a niche producer of flat-rolled stainless and special steels which are produced as quarto heavy plates and hot and cold rolled coils. Annual production of ACRONI in year 2014 was approximately 430.000 tonnes. Acroni exports more than 80 % of its products, and it is the biggest supplier of stainless steel quarto plates in Europe [9].

ACRONI and environment: For centuries, Acroni has been manufacturing high-quality steels that have been successfully selling on the most demanding markets. Gradually reduced environmental impacts and protection of environment has become one of the priorities of company's strategy.

ACRONI's environmental awareness constantly grows, what can be proven with international standards ISO 14001, which gives the requirements for environmental management systems, confirms its global relevance for organizations wishing to operate in an environmentally sustainable manner, and OHSAS 18001, an international occupational health and safety management system specification. They introduce environmentally friendly technological processes that have the least impact on the environment. Equal attention is devoted to the management of energy sources. In ACRONI they constantly monitor emissions of wastes, gasses and waste waters [10].



Figure 2. ACRONI production: from steel scrap to final products.

3. LIFE CYCLE ASSESSMENT

What is LCA? Life cycle assessment (LCA) involves the evaluation of some aspects - often the environmental aspects - of a product system through all stages of its life cycle. Sometimes

also called “life cycle analysis”, “life cycle approach”, “cradle to grave analysis” or “Ecobalance”, it represents a rapidly emerging family of tools and techniques designed to help in environmental management and longer term, in sustainable development.

What is a product’s life cycle? Simply stated, the life cycle of a product embraces all of the activities that go into making, transporting, using and disposing of that product. The typical life cycle consists of a series of stages running from extraction of raw materials, through design and formulation, processing, manufacturing, packaging, distribution, use, reuse, recycling and, ultimately, waste disposal. Environmental-energetic analysis of the process which is the base for Life Cycle Assessment (LCA) is the same for the steelwork, foundry and bank.

In the year 2011 the steel producer ACRONI was invited to cooperate in the project of life cycle assessment (LCA) for the two groups of steel grades 304 and 316. For the project has been used the standard software for LCA analysis GaBi. The aim of the project was to show that steel producing industry knows how important is the synergy between steel producer and society. Rational handling and manipulation with materials and resources considering two main principles:

- reduction of consumption of natural and unrenewable resources, and
- reduction of pressure on environment, when materials and products become unapplied and transformed into a waste.

In the beginning of year 2015 the automotive parts producer CIMOS d.o.o started with the production of new compressor housing AUDI EVO (for gasoline engine 3.0) of new generation (Figure 3).

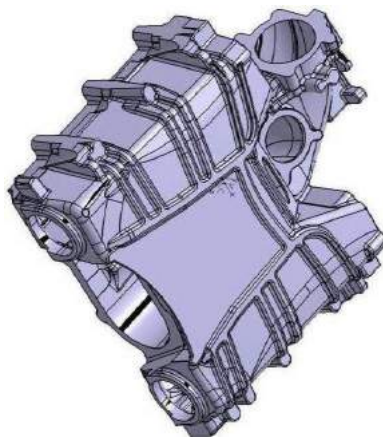


Figure 3. New compressor housing AUDI EVO.

There have been carried out both: LCA and SWOT analysis of the selected testing product, which has practical the same technical characteristics and material (AlMgSi alloy), however is around 5 % lighter than its predecessor (11.056 : 10.467 kg). This improves quality, increases productivity and protects the environment, reduces energy consumption and reduces raw materials.

4. CONCLUSION

In the frame of presented study is discussed life cycle assessment (LCA) method in the praxis the most used and established method for detecting the effects of the product on the environment.

The potential application of LCA for the Slovenian steel producers, especially the case of ACRONI the biggest steel producer in Slovenia, has been analysed.

Heavy plates of two typical steel grades from ACRONI production program were analysed during the pilot project using standard LCA software package GaBi. At the same time the LCA, and SWOT analysis of new compressor housing AUDI EVO have been carried out.

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