Some aspects of gas meter quality and analyzing the sustainability of a gas meter element

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Abstract. This paper refers to analyzing some components of a natural gas meter. There is a question of making the gas meter design and execution process more efficient. A description of the components of a gas meter is made. It is proposed to improve the natural gas meter. Designing is an important and vital stage in the product's lifetime, an analysis of the environmental impact and the durability of the product is done, so an analysis is made using the SolidWorks-CAD software. The object of the analysis is a toothed wheel, part of the mechanical bimetal temperature compensator. The case study presents a sustainability report showing a decrease in manufacturing cost, an improvement in the materials used, and a lower impact on the environment.

1. Introduction

In this paper, emphasis is placed on the design and execution quality of a natural gas meter in close connection with the production cost and its durability.

Due to the emergence of new raw materials and manufacturing industries in recent years, there have been a multitude of effects with negative impact on the environment. The negative effects of the manufacturing process are reflected on the environment through the occurrence of pollution and climate change. In this regard, the need to protect and preserve the environment has emerged immediately, such as environmental taxes, subsidies for companies that have preventive measures against pollutants, directives and laws for manufacturers, etc.[1].

Sustainable development / sustainability is defined by the World Commission for Environment and Development as a development that seeks to meet the needs of the present without compromising the ability of future generations to meet their own needs [2].

Sustainable development is an obligation that must be undertaken to ensure a future for future generations.

It is said that the absence of quality is expensive, so it is necessary to implement a quality control system.

For a successful project, we need to evaluate the product life cycle [3].

LCA (Life Cycle Assessment) is a management technique that involves assessing and analyzing the environmental consequences of the product, from product extraction and processing of raw material, design phases, manufacturing, use, repair, maintenance and recycling phase, going to product reintegration into the environment. Also, the environmental impact due to transport needs to be remembered [4].

A very important aspect is the clients trust, who have to occupy an important position in the organization activity. Improving product quality can be done either by improving existing features, either by increasing the number of product quality features. The American Quality Society (ASQ) defines quality as a continuous effort of organizations to achieve all the processes better and better, in other words to obtain goods and services to better meet the growing needs of consumers. Failure to appreciate all the features of a product or service may lead to a deacrease in quality.

To reach the quality level of a product, Deming recalls some principles [5]. which in his opinion are exclusively in the responsibility of the management and they can not be delegated: continuous improvement of product and service quality based on a plan; dropping the acceptable level of quality; introducing statistical quality verification methods; requesting proof of statistical evidence from suppliers; discover the problems; use modern staff training methods; ensure all employees the tools they need to conduct their activity properly; encourage communication and eliminate fear, so every employee can tell their opinions.

2. Components study

Gas meters with deformable walls are volumetric gas meters.

Gas volume measurement is carried out using deformable wall cameras, with or without temperature conversion devices.

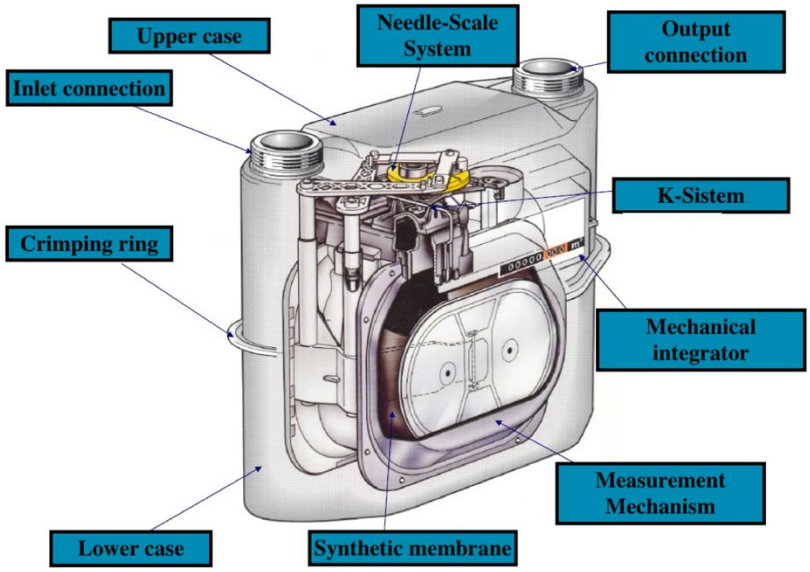


Figure 1. Gas meter [6]

Gas meters consist of a measuring mechanism, a housing assembly and a mechanical integrator for recording gas consumption. The measuring chambers are filled and housed periodically, and the membrane movement is transmitted via a gear to a crankshaft and it moves the gas intake control drawers. Through a toothed wheel system, the motion is transmitted by means of a magnetic coupling to the mechanical integrator of the gas meter. The gas inlet is possible via the inlet of the meter and the gas outlet through the outlet of the meter [6].

Gas meters with deformable walls must meet the following technical characteristics: the meter housing must be thick enough for the pressure range, and the joint between the upper and the lower case must be sealed, protected against corrosion. The housing should be made of aluminum or galvanized sheet; the meter components must be resistant to the corrosive substances that they come in contact with; to avoid fraud in the distribution system, the meter must be provided with a gas leakage locking system in the reverse direction; the meter's membrane must be made of synthetic, corrosion-resistant

material; the integrator must be protected by a transparent lid, light-proof and other environmental factors.

In the following papers it is proposed to develop a 3D model of a natural gas meter that is capable of preventing and discouraging all known unauthorized intervention methods [7].

The 3D model will incorporate the following safety features:

- the disappearance of the metrology marks, and the integrator will be integrated into the meter housing, so that everything is under pressure. Inscription on the transparent cover of the registration mechanism of the manufacturing year and the device series, plus safety belts;
- input / output connections will be provided with metalic filter;
- a flap, with the possibility of automatic gas closing;
- an automatic meter reading system based on radio frequencies and concentrators;
- an alarm system for removing the gas meter from the plant;
- temperature and pressure sensors [8].

3. Case study

For sustainability analysis, the SolidWorks CAD software was used, which incorporates a product life cycle assessment module (LCA). The subject of this case study is a toothed wheel, part of the bimetal mechanical temperature compensator (Figure 2).

For mechanical compensation with the gas temperature a bimetal is used.

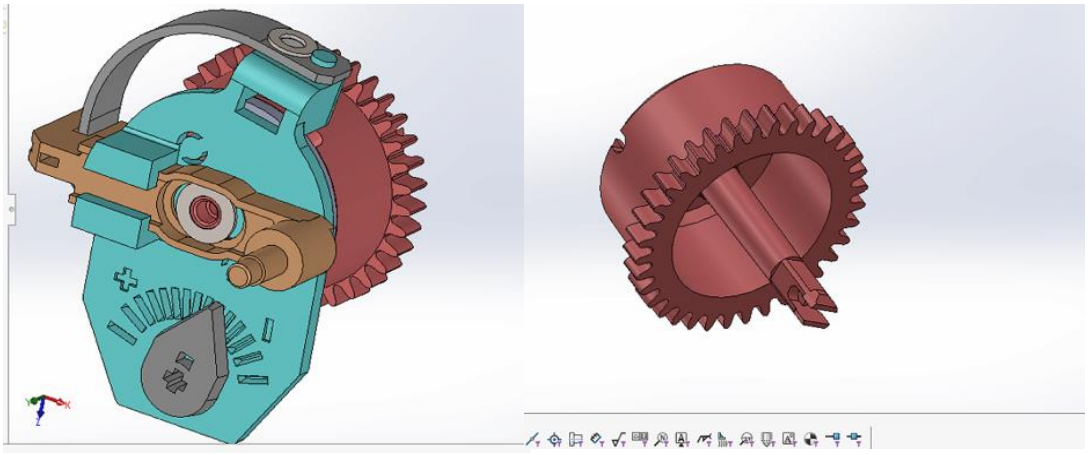


Figure 2. Mechanical compensator with bimetal/ cogwheel

A bimetallic element is fixed to the disc of the metering mechanism. This influences the movement of the measuring chambers so that the measuring accuracy within the stated temperature range remains within the permissible limits.

Bimetal is an assembly made of two metal welded elded blades, which under the influence of temperature can perform a limited movement, developing a certain force.

Given that a natural gas meter has plenty of plastic and metal components, a complete sustainability analysis should be done for each piece in order to reach a result that will have a major impact. In this case study we will only focus on a plastic gear wheel part of the bimetal mechanical temperature compensator.

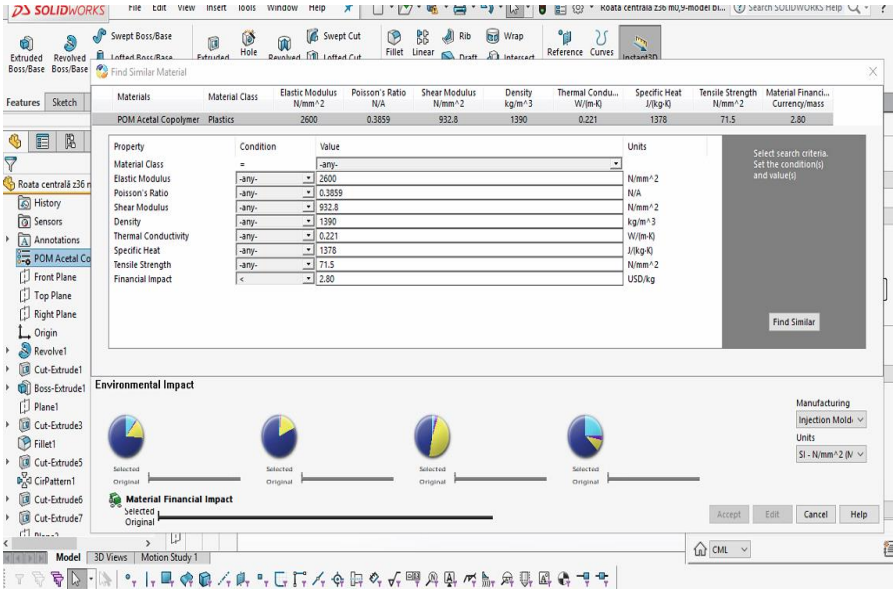
In the first phase of this case study, 3D bimetallic temperature compensator assembly (Figure 3) was designed. After designing the assembly, the sustainability module was run, which is an integrated part of SolidWorks CAD software.

Subsequently, the type of toothed wheel manufacture was selected, injection molding and material type, POM Acetal Copolymer.

This module makes a comparison between the same product from an environmental point of view depending on what the material it is made of, the manufacturing mode, product duration usage, etc..

The module analyzes the input data and tracks the product from the manufacturing stage, the lifetime, the transport and removal of the product from use.

We are provided with information on the gas and electricity consumption consumed to produce/ pack the product, the manufacturing cost per unit. It can also be selected if the piece is painted or not (in this study the piece is unpainted), product duration usage and the length of time it is programmed to withstand the product.



It is possible to select the product manufacture place and the product place of use. Depending on this, the module makes a calculation that reflects transport costs (by truck, train, boat and airplane).

Figure 3. Material tab

Obviously, if the product is used at a great distance from the manufacturing site, the impact is greater on the environment due to transport.

In the sustainability report we also receive information about the product end of life, how much can we recycle, how much it is incinerated and how much it should be transported to a landfill.

In the next phase I changed the material from which the wheel is made of, from POM Acetal Copolymer in Medium / Low Density Polyethylene, and the manufacturing process remained the same, injection molded.

I have selected Europe as the manufacturing area and Australia as usage area. This shows us that the product has a negative impact on the environment, due to the transport cost from Europe to Australia (Figure 4).

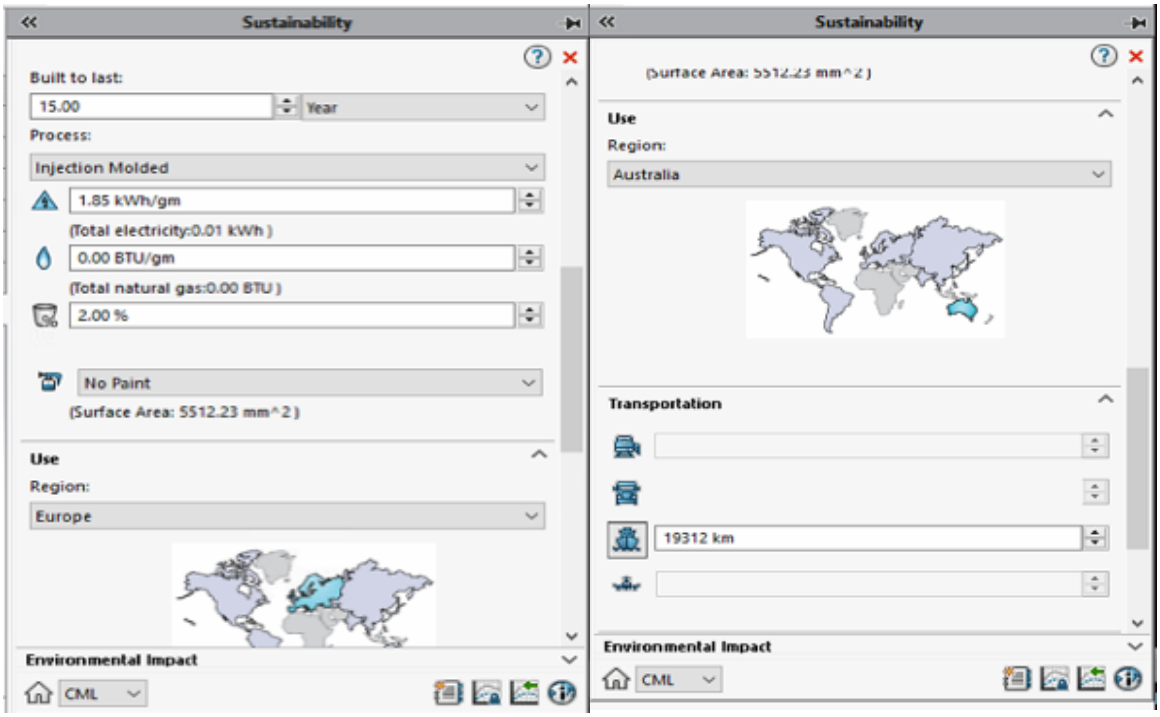


Figure 4. Input menu

By comparing the two types of materials we can see that medium / low density polyethylene has a much lower environmental impact, and the manufacturing cost is also lower.

The environmental impact for polyethylene is shown in (Figure 5).

So we have a 60% reduction in carbon footprint, a drop in total energy consumption by 45%, a decrease in air acidification by 44%, a decrease in water eutrophication by 65% and a decrease of material cost by 39%.

We have the opportunity to get a complete report using this module, which can help organizations.

Sessions can be organized within the organization and talk freely on the subject so that the best decision can be made.

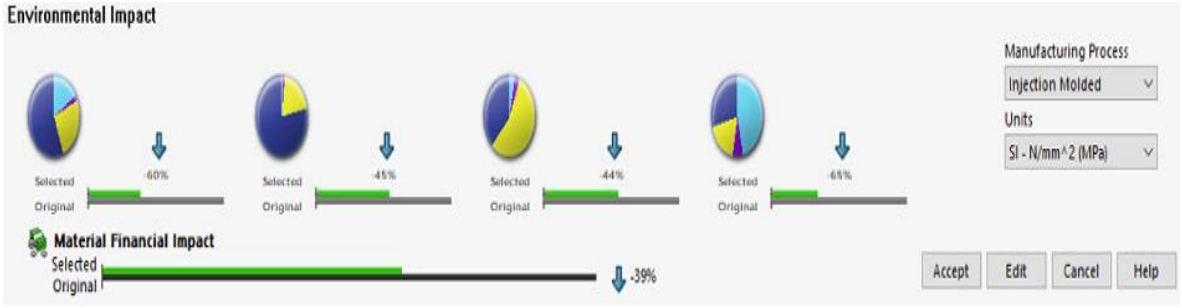


Figure 5. Results

4. Conclusion

As a result, we have to understand that the quality of a product is a necessity.

Gas metering devices must evolve in such a way that the safety in operation is greatest and the fraudulent part disappears.

Organizations must understand that if a product is not executed perfectly from the beginning, losses can be high or very high.

Following the sustainability analysis applied to only one piece of the gas meter, we can see a decrease in manufacturing cost and the environmental impact is diminished.

So I think companies should integrate such analyzes into their management process because the benefits can be seen with the naked eye, for both the organization and the environment.

This analysis can be done for the whole measuring device, and then we can compare the results obtained.

The following papers will also address more sophisticated sustainability studies for natural gas meters.

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