Rationalization of Small Induction Machines

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Abstract — **The work deals with the possibility of assessment of optimal costs for a specific product. In this paper it is described the sphere of costs, their segmentation and assessment. From the aspect of product price calculation it is very important to set a price level of particular costs. The price level must be acceptable from the aspect the whole company economics (returns).**

Keywords — electric machines, cost, calculation.

I. INTRODUCTION

The price set for a specific product has a crucial role in the manufacture of any element (part, semi-finished product or whole product - machine) from the viewpoint of a business strategy. From the viewpoint of the company market position, this price should be competitive. This price level depends on two major features defined below, the total cost volume (costs spent) and the profit volume. In every company the magnitude of profit is given by the long-term (strategic) plan ensuring economic development. That is why company managers rarely proceed to a change of the plan within the limits of the product price acceptable for the customer. However, the level of costs of a specific product may be adjusted to set a competitive final price.

II. MAIN GOALS OF THE WORK

The main objective of the project program was to achieve higher technical and economic parameters of electric motors and in particular in the following spheres : - improved reliability - improved quality - lifetime - reduction of production time - cost savings of material intended to achieve these goals by using new knowledge and experience in the electrical field, metal processing and information technology.

One of the main goals of this work is the more detailed analysis of various possibilities for solving the efficiency problem and involving a larger number of machines, including small machines.

A more detailed analysis of different possibilities for solution of the efficiency problem and inclusion of a wider range of machines, i.e. not only automobile electric machines but also *small electric machines for general use*, belongs among the main goals of the work. We propose the following course:

- To analyse the cost theoretically for the individual machine groups, for example small induction motors, to verify the proposals for concrete samples, and to prepare source materials for implementation, decreasing of production time and cost of materials.

The final goal of the work is the research, development, and implementation of a new generation of small electric machines with optimized (increased) costs, efficiency and improved characteristics.

III. ELECTRIC MACHINES

The term “electric machine” refers to a device that converts one form of energy into another on the principle of electromagnetic induction, wherein at least one of them is electric energy. For example, a transformer converts certain properties of electric energy (voltage level, current) into other one. Every electric machine according to this definition is characterized in that it contains three elements, namely: a primary electric circuit, magnetic circuit and a secondary electric circuit, wherein the electric circuits are coupled by a magnetic field. Electric machines can be grouped by different criteria: from the viewpoint of the electric current system, from the viewpoint of mechanical motion, by energy flow direction and energy type, by voltage range, by output, or by principle of action.

To meet the goals of our project it were selected from a variety of small machines induction motors for universal use - first use in households - for example through the shredder drive fans to the industry - such as control valves in power plants. They are made for a single phase supply with capacitor or as three phase types . Both types exist in two pole or four pole versions. Some motors have mounted gearbox (worm usually, one or two levels).

The rotor diameter rotor is 38 mm, the stator diameter is 85 mm, square of the stator plate is 72 x 72 mm. The length of the stator pack (slang "length of iron") is from 10 to 90 mm. There was a change in the shape of the stator plate slot. Partial rationalization measures, of course, take place continuously as changing insulation sheet, a change from single track tool for cutting sheet metal on the double track, change of the synthetic water-soluble impregnant, changes in technology for the shaft manufacture , etc.

Rationalization took place in several waves and in determining the consumption standards of work which was not ideal, the quality of parts and, consequently of the whole machine . Of approximately 80 machine types

it was selected a typical representative as an average (Fig. 1).

Fig.1 Small Induction Motor – Old Version

Fig. 2. Small Induction Motor – New Version

IV. RATIONALIZATION

As already stated above, it can be understood as a rationalization of the various measures increasing of the economic benefit. Among the specific objectives of rationalization it may be included:

- Removal of losses
- Avoid running on empty and duplication
- Increasing of productivity and quality
- Reducing of its own costs
- Reducing risk
- Increase of revenue
- Regulation of consumption and production

and others.

Rationalization in a company can be divided into two areas:

Technical rationalization and

economic rationalization.

The above text implies that rationalization can be performed at all possible levels of business. However we consider only the product rationalization costs. This rationalization needs to be splited into two completely different levels: technical and economic. The technical part will be approached for possible technical measures that would reduce the cost of the product. In the economic part it will be examined not only the types of the costs, the determination, calculation and production can be factored into the overall management of the company.

The project "Rationalization of the cost of small electric machines", which cooperates with the company ATAS electric has already been approached to changes in the technical part. This technical part needed to be split into two levels, in which changes have been made:

- organizational and technical measures,
- electric machine design changes.

Block diagram of the procedure for rationalizing of the production cost of small electric machines is shown in Figure 3.

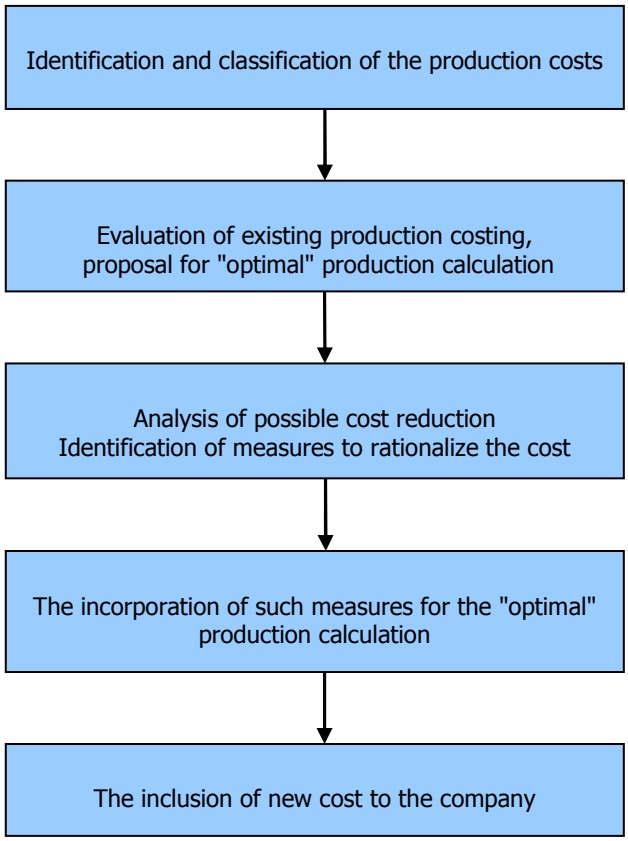

Fig. 3 Cost rationaliation for production of electric machines

V. COSTS

It is to note in general that if there is no cost, there is no benefit or gain as a result. The following sentence can be used as a definition of cost: Cost is the consumption of individual items (material, human factor in the form of wages/salaries, machines, etc.) expressed in monetary form, spent in order to achieve the required gain. To make the use of the costs spent profitable, the level of costs must be lower than the gain achieved. From the viewpoint of cash flows within the company, it is important to distinguish between incurred costs and expenditures. Expenditure can be viewed as physically expended money for a specific transaction or item. On the

contrary, a cost is admissible without previous expense of money and is important from the accounting point of view. Therefore, business expenses are recognized in terms of the cash flow.

In managerial accounting, costs are examined in terms of purposefulness, i.e. whether they were spent purposefully. In addition, profitability of the cost invested is examined – so the cost has to be adequate to the subsequent gain, and the allocation of the cost, i.e. cost assignment to the future gain is also assessed to a considerable extent.

All of the three aspects mentioned above (accounting, cash flow, managerial accounting) occur in different time dimensions when the cost incurred is assessed. Purposefulness in terms of managerial accounting point of view, or quite conversely, a cost may precede an expenditure (all depends on the method of payment). And the cost is allocated to a specific operation (product, work done, whole object – building) in managerial accounting at the time when the given product is handed over to the user. This means that accounting works with gains admissible for the operation and then also with receipts. Again, whether the gain precedes the receipt or *vice versa*, or whether the gain occurs at the same time as the receipt depends of the method of payment.

Costs can be classified from different points of view: from the time point of view, classification by elements of costs, calculation classification, internal classification, classification by purpose, classification by volume.

VI. Definition of Calculation

Calculation is defined as a computation of planned or incurred costs for a specific item that can be expressed as a product or service supplied, or as a specific operation from the internal point of view. Such computations can be used within the company to express, for example, calculation of profitability, calculation of overheads, production calculation or the most extensive part of calculations, calculation of planned capital projects. It is therefore obvious that information values contained in the company calculation subsystem cannot be omitted.

When working out calculations, different calculation methods are used, which are grouped into the following two categories: division costing method (simple costing, stepped costing, costing with index numbers) and overhead rates costing method (summation and differentiated method). The difference between the two categories can be described as follows: the former, division costing method, employs the allocation of costs to operations related to quantity defined by different calculation units, whereas the latter, overhead rates costing method, employs the cost allocation base for adding some costs.

A. Cost allocation base

The cost allocation base can be defined as a linking member between indirect costs and the calculation unit. Its function can be expressed as a base of percentage display of indirect costs (partial overheads). An "adequately" set volume of indirect costs depends on a well-chosen cost allocation base. However, selecting the volume of costs shown in the cost allocation base is very difficult and poorly definable in some cases. The basis for determining the cost allocation base should be, in the first place, the causal connection not only between the level of indirect costs and the respective operation, but also the relationship between the costs shown in the cost allocation base and the indirect costs. If it is impossible to apply the principle of allocation, which is the most accurate method in terms of indirect cost volume determination, to the cost allocation base selection, then two other options may be used. The first option of working out indirect costs is based on the level of acceptability, i.e. what level of indirect costs may be considered so that the final, calculated price shows an image of competitiveness or marketability. It is obvious that the volume of indirect costs, in terms of cost allocation to the respective operation, is not accurate but only "informative". The last possibility of selecting the cost allocation base and then determining indirect costs is the principle of averaging, i.e. what are the average indirect costs of the specific operation. Again, the averaging method shows that it is an "informative" determination of indirect costs, and the real display of indirect costs on the specific operation is out of question.

B. Calculation formula

Whether it is the case of preliminary or final calculation, or a calculation for price strategy has to be worked out, working out of the "general" calculation is always based on an adequately selected calculation formula. At this point, the calculation formula should not be seen as a standard formula for every calculation. Individual calculation formula items should be continually adjusted to requirements and conditions of the company. That is why emphasis is put on the preparation phase during calculation. Any calculation processing should be based on decision-making tasks within the company. This means that the preparation of calculations should be adjusted when all needs of the company are found out and decided about.

In addition, costing and pricing differentiation is important because of access to the calculation creation that is based on the set calculation formula. The calculation formula structure can be as follows: retrograde calculation formula, calculation formula distinguishing fixed and variable costs, dynamic calculation, calculation with a stepped spread of fixed costs, calculation of relevant costs. Probably the most frequently used calculation formula in practice is dynamic calculation based on the division of costs into direct and indirect costs with respect to further division of

costs connected with the reproduction process – variable and fixed costs. For calculation and optimalization it were used two methods covering due.

Direct costs – include such costs that are quantifiable per calculation unit. Therefore, they can be accurately defined and their value determined. The direct costs consist of:

- Direct material – all materials used directly in the production that can be related to a calculation unit (for example 35 - 38%).
- Direct labour – these are wages of factory personnel that can also be quantified per calculation unit (55 - 58%).
- Machines – costs connected with the use of machines, expression of their wear, repair and maintenance costs.
- Other direct costs – in the first place, these are costs connected with social security and health insurance associated with factory personnel wages, then travel, transport and assembly costs, all on condition of a relation to the calculation unit (4 – 10%).

Indirect costs – costs than cannot be quantified directly per calculation unit. So they are expressed as a percentage and are related to the selected cost allocation base. Indirect costs include different overhead categories:

- Manufacturing overheads – these include salaries + related statutory insurance of clerical staff, machine write-offs, energies consumed in the production etc.
- Administration expenses – costs associated with management and administrative component of the company, consumed energies, rental paid etc.
- Selling expenses – sum of costs associated with the sale of the product range offered.

Profit – again, this is an indirect expression of this value, so it is quantified as a percentage in relation to the cost allocation base. As it is impossible to identify some indirect/overhead costs directly because they change with the production volume, it is expedient to consider costs divided into fixed and variable costs that would refer to the relation with the varying reproduction process.

- Fixed costs – such costs that do not change their value depending on the varying volume of production (building administration, rentals of leased machinery and equipment, advances for energy consumption etc.)
- Variable costs – such costs depend on the production volume, so their amount changes with the production volume (factory personnel wages, material consumed, energies consumed, machine wear etc.)

VII. CONCLUSIONS

From a comparison of the final machine calculation with the original calculations it can be seen that the savings achieved were through both material and substantial savings in production time (time consumption). In comparison with the design calculations, which were our goal and vision, it appears the increase in the material as a failure, but it should be noted that during development there was a significant intervention into the construction of the machine, unlike the originally proposed solution (using another lie. Shields, used ball bearings as opposed to self-lubricating, bond stator is impregnated, etc.). Despite that significant structural differences compared with the proposal to shorten the production time succeeded in this, our estimation is correct. Comparison of the calculations is valid only for one machine, without taking into account the number of pieces produced, number of purchased materials, etc. For a better evaluation it would be necessary to use a spreadsheet.

Fig.3 Laboratory samples – measurement design

In conclusion it is to say that with a view to saving costs associated with the manufacture of electric machines and the overall economic gain (profit), it is possible to use relevant changes in individual parts of production, i.e. manufacturing, sales and overheads. It is to note, though, that even defining these changes brings about a cost burden for the company. It is therefore necessary to make ongoing calculations of individual costs, but customer requirements have to be taken into account in the first place to settle the company position on the market. The results of research and development are very positive - the production time for the machines was reduced by 10% and material costs by 50%.

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