Product Introduction

Eco-0.4cc Pump

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1 Introduction

Takako Industries, Inc. mass-produces and sells the TFH Series small axial piston pumps (the "small pumps") shown in Photo 1. We sell the small pumps to a variety of industries and have received high evaluations for the hydraulic pumps' efficiency and compactness. However, some customers have earnestly requested that we provide small pumps with minimum specifications at more reasonable prices. These customers do not necessarily require the maximum specifications or performance of the current mass-produced counterpart, but they want to maintain the features of the piston pump. In order to promote further sales expansion, we must respond to these customers' desires.

Recognizing the need for economical (or inexpensive) small pumps, Takako Industries began developing a 0.4 cc/rev pump. It was the smallest pump in the series and the most in-demand by customers, who wanted it to be sold at a reasonable price. This report introduces our efforts to develop an affordable 0.4 cc/rev small pump (the "Eco-0.4").

Photo 1 Small axial piston pump series

2 Specification of the Product under Development

Table 1 compares the specifications of the currently mass-produced TFH-040, the Eco-0.4 under development, and the desired product of customers (with specifications selected from the results of interviews with customers).

The Eco-0.4 has a maximum discharge pressure of 14 MPa, which remains unchanged, and a maximum rotation speed of 3,500 min^{-1}, lower than the 5,000 min^{-1} specified for the THF-040. We discussed reducing the overall length, outside dimensions, and weight of the currently mass-produced product as much as possible. However, we prioritized reducing the overall length because more customers wanted this than reducing the outside dimensions.

3 Approach to Achieve Target Costs

3. 1 Allocating Target Costs

We discussed with our Sales department to set a target selling price for the Eco-0.4 and decided on the target cost for that price. We used the VE approach [Note 1)] to allocate costs to each part against the target cost. The following shows our general flow of discussion:

Note 1) An acronym for Value Engineering. It is an approach to maintaining or reducing costs while

Table 1 Comparison of specifications of TFH-040, Eco-0.4, and customer-desired product

Item		TFH-040 (mass-produced product)	Eco-0.4 (product under development)	Customer's desire
Displacement volume	[cc/rev]	0.401	0.403	Around 0.4
Discharge pressure	[MPa]	14	14	11
Rotation speed	[min^{-1}]	5000	3500	3300
Rotation direction	[−]	Bi-rotational	Bi-rotational	Bi-rotaional
Operating temperature	[℃]	+ 5 ～ + 60	+ 5 ～ + 60	Under discussion
Outside dimensions	[㎜]	□30 × 61.4	□34 × 53	Smaller
Weight	[g]	270	225	Lighter

enhancing or preserving the quality and functions of the product or service.

[1] First, divide the TFH-040 components into four groups based on their functions. Then, calculate the cost of each group to determine the cost ratio among them.
[2] Prioritize the four functions to be subjected to VE.
[3] Allocate a target cost to each function.
[4] Based on the results of steps [1] to [3], allocate a target cost to each Eco-0.4 functional component group.
[5] Allocate a more detailed cost to each part of the component groups.

In fact, we could not achieve the target without fundamentally reducing costs. Therefore, we considered reducing the number of parts in step [5] above. As a result, the Eco-0.4 had 20% fewer parts than the TFH-040, which contributed to both cost reduction and resource conservation.

3. 2 Part Cost Reduction Measures

Photo 2 shows an Eco-0.4 sample product in the development stage. Its housing and other casing parts were machined from solid blocks. In the mass production stage, however, as shown in Fig. 1, the casing parts use an aluminum die-cast housing to reduce processing man-hours and product weight. The internal parts of the pump use sintered materials and stamped parts to reduce costs. In addition, we aim to improve productivity and reduce costs by diverting parts currently produced in volume.

We are also working on this cost reduction activity by producing parts at Takako Industries' global production sites and by developing new suppliers in cooperation with the Purchasing and Procurement departments.

Photo 2 Eco-0.4 sample product

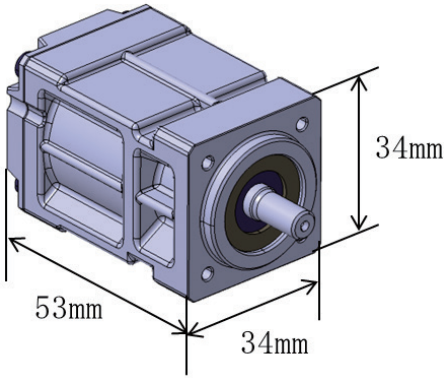

Fig. 1 Eco-0.4 mass-production model

4 Performance

4. 1 Efficiency Characteristics

Our customers typically use electric motors to power small pumps. They adjust the pump flow by changing the motor speed. Therefore, the TFH series or the Eco-0.4 is required to deliver stable performance (volumetric efficiency [Note 2]) across the low to high speed range.

Fig. 2 shows the volumetric efficiency characteristics of the Eco-0.4 when the discharge pressure is held at 14 MPa and only the pump speed is varied. The volumetric efficiency of the Eco-0.4 is approximately 1 to 2 percent lower than that of the mass-produced TFH-040 across the entire speed range. Thus, we have confirmed that the Eco-0.4 successfully maintains the features of a piston pump.

Note 2) The ratio of the actual measured displacement volume to the theoretical displacement volume (JIS B 0142: 2011).

The actual displacement volume is affected by the tolerances of each component as well as by volume loss due to pump leakage.

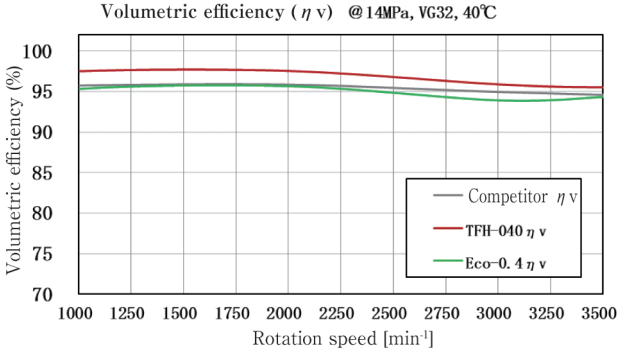

Fig. 2 Comparison of volumetric efficiency characteristics

4. 2 Durability

To verify its durability at the development stage, we subjected the Eco-0.4 to the same tests as the TFH-040, including continuous and repeated durability tests. The Eco-0.4 showed no performance decrease or component malfunction in any of the tests, proving its durability. Fig. 3, for example, compares the volumetric efficiency characteristics before and after the continuous durability test. The results shown in Fig. 3 are from testing in which the pump speed was held at 3500 min^{-1} and only the discharge pressure was varied.

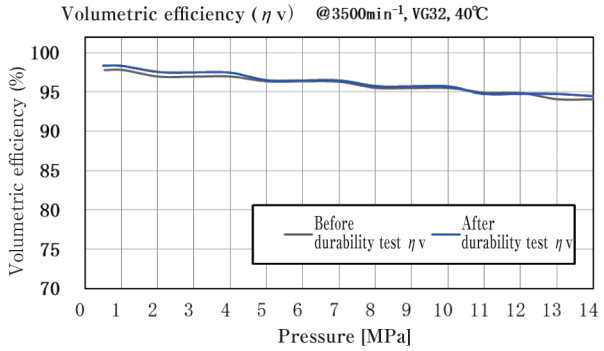

Fig. 3 Comparison of volumetric efficiency characteristics before and after continuous durability test

5 Exhibition at IFPEX 2024

Takako Industries participated in the IFPEX 2024 exhibition held in September 2024. Photo 3 shows our booth at the exhibition, where we showcased a sample of the Eco-0.4 (Photo 4). Many visitors were interested in the compactness of the mass-produced TFH series, the world's smallest class of small pumps. Along with introducing the TFH series, we also presented the Eco-0.4. Some visitors expressed more interest in the Eco-0.4, making us recognize a demand for an economical (or inexpensive) type of the product.

Photo 3 Takako booth at IFPEX 2024 exhibition

Photo 4 Eco-0.4 presentation board

6 Expected Applications

Through the exhibition (at IFPEX 2024) and sales activities, we received numerous inquiries regarding brake- and steering-related applications, as shown in Photo 5 and Fig. 4, respectively. All of these applications require small pumps that can instantly deliver flow and control flow according to steering.

Customers can choose between the mass-produced TFH-040 and the Eco-0.4 based on their desired cost and performance. In either case, we will make optimal proposals to satisfy our customers.

Photo 5 Trailer brake

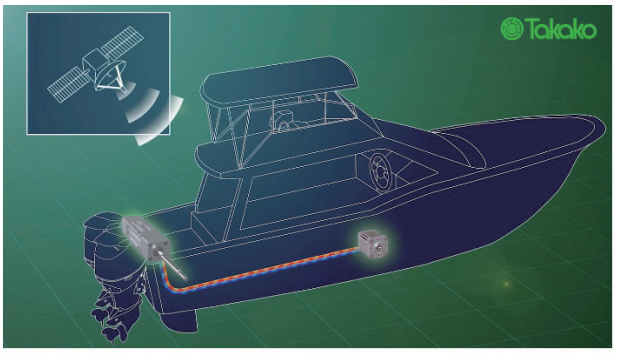

Fig. 4 Ship steering

7 Results of Development

Table 2 summarizes the results of developing the Eco-0.4. Compared to the existing mass-produced TFH-040, the Eco-0.4 features reduced resource usage, a lighter weight, and a shorter overall length while maintaining performance. Additionally, cost estimation results showed that the fundamental cost reduction target set forth in section 3.1 was achieved, though details are omitted here. Therefore, the Eco-0.4 satisfies the requirements for an economical (or inexpensive) small pump.

Table 2 Eco-0.4 development results

Volumetric efficiency @14 MPa, VG32, 40℃	: Equivalent to our existing model
Cost reduction	: Target achieved
Resource reduction	: 20% fewer parts than our existing model
Weight reduction	: 17% lighter than our existing model
Overall length reduction	: 14% shorter than our existing model

Note: “Our existing model” refers to TFH-040.

8 Prospects

As of the time of writing this report (December 2024), the development for product commercialization has been completed. We will now transition to development tailored to customer inquiries. We have already received several inquiries from Japanese and overseas customers, but some of their detailed requirements are unclear. Therefore, we will promote development while collecting and organizing accurate information, updating it as needed.

9 In Closing

We would like to express our sincere gratitude to the external and internal project members, including those from the Sagami Hydraulics Engineering Dept. of the HC Operations and Materials Engineering Sect. of the Basic Technology R&D Center of Engineering Div. of KYB Corporation.

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