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Reduction Cost in Endplate-B Material Component for Oil Filter Bypass System with Redesigning

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Abstract

The bypass system in spin-on type oil filters plays a crucial role in maintaining engine cleanliness and performance by allowing oil to flow when excessive pressure occurs. A critical component of this system is endplate-B, which fulfills dual roles: providing structural support and functioning as an interface for oil passage during bypass operations. However, the relatively high material usage and cost associated with the current design of endplate-B pose challenges in manufacturing efficiency. The objective of this study is to minimize the material cost of endplate-B by optimizing its dimensional geometry without compromising its structural and functional performance. The research methodology encompasses dimensional redesign, structural analysis, and performance validation under simulated operating conditions. The findings indicate that strategic dimensional modifications can substantially reduce material usage while preserving mechanical strength and functional integrity. The implementation of this optimized design provides a cost-effective solution for the manufacturing of oil filters and contributes to broader efforts to improve production efficiency in the automotive component industry.
Keywords: *oil filter, by-pass relief valve, reduce cost, cost material, design*

Abstrak

Sistem bypass pada oil filter tipe spin-on memiliki peran penting dalam menjaga kebersihan dan kinerja mesin dengan memungkinkan aliran oli saat terjadi tekanan berlebih. Salah satu komponen utama dalam sistem ini adalah endplate-B, yang berfungsi sebagai penyangga struktural sekaligus jalur aliran oli saat kondisi bypass. Namun, penggunaan material yang relatif tinggi pada desain endplate-B saat ini menyebabkan biaya produksi yang cukup besar, sehingga menjadi tantangan dalam efisiensi manufaktur. Penelitian ini bertujuan untuk menurunkan biaya material komponen endplate-B melalui optimalisasi dimensi geometrinya tanpa mengorbankan kekuatan struktural dan fungsi operasionalnya. Metodologi yang digunakan meliputi redesign dimensi, hingga, serta pengujian performa pada kondisi operasi yang disimulasikan. Hasil penelitian menunjukkan bahwa modifikasi dimensi yang strategis dapat secara signifikan mengurangi penggunaan material, dengan tetap mempertahankan kekuatan mekanik dan integritas fungsi. Penerapan desain yang telah dioptimalkan ini memberikan solusi efisien dalam produksi oil filter, serta mendukung upaya peningkatan efisiensi biaya pada industri komponen otomotif.
Kata Kunci: *filter oli, katup relief by-pass, penurunan biaya, biaya material, desain*

1. Introduction

The bypass system in spin-on type oil filters is essential for maintaining proper lubrication in internal combustion engines, particularly when the filter element becomes clogged or when oil pressure exceeds safe operating levels [1][2]. This mechanism allows oil to continue circulating through the engine, preventing critical damage caused by oil starvation [3].

One of the key components in this system is endplate-B, which functions as both a structural support and a channel for oil flow during bypass conditions. While often overlooked in complexity, endplate-B contributes significantly to the mechanical stability and operational reliability of the oil filter assembly. In conventional designs, endplate-B is manufactured with fixed dimensions that prioritize mechanical robustness, often without considering material efficiency or cost optimization.

In recent years, the rising cost of raw materials has encouraged manufacturers to explore opportunities for cost savings through design improvements [9][10]. In this context, redesigning endplate-B by modifying its dimensional geometry offers a promising strategy to reduce material usage and lower production costs. Instead of changing the material or introducing new manufacturing techniques, this study focuses on simple dimensional adjustments to achieve material efficiency.

The approach involves a comparative analysis between the original and modified endplate-B designs, supported by physical measurements, mass calculations, and performance assessments based on current production standards. By maintaining compatibility with existing filter configurations and ensuring adequate structural performance through empirical evaluation, the redesigned component is intended to provide a cost-effective alternative for oil filter production.

This research contributes to ongoing efforts in the automotive industry to improve manufacturing efficiency through design-based solutions. The findings demonstrate that even minor geometric modifications to standard components like endplate-B can lead to significant material savings, without compromising the functional integrity of the system [11][12].

Based on observations and current specification needs, it was found that the Material cost for the endplate-b can be reduced by decreasing the height of valve chamber from 22 mm to 15 mm. Additionally, this approach will help save Material used in manufacturing the spring, also merging part number variant to reduce process cost.

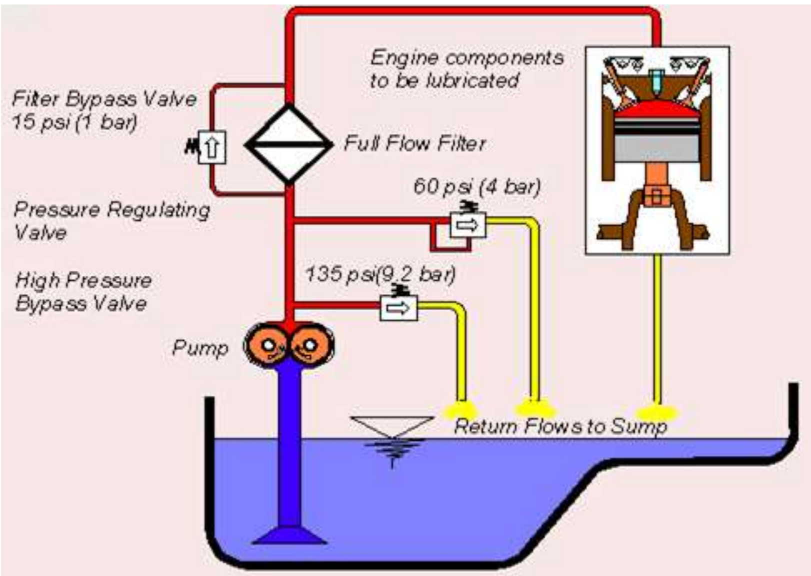

Fig. 1: Diagram of oil filter system

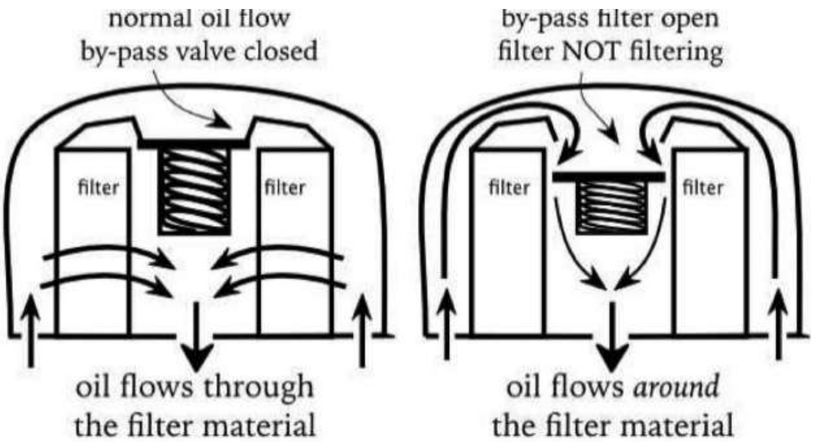

Fig. 2: Oil filter with by-pass valve system

2. Material and Methods

This study employs a comprehensive methodology to redesign the C-15271 endplate-b part number component for cost reduction. The approach integrates several analytical tools and testing methods, including Pareto analysis, SWOT analysis, impulse testing, and load testing, to ensure a thorough evaluation of the redesigned [13].

Pareto Diagram

A cost analysis using a Pareto diagram, as shown in **Fig. 3**, was conducted to identify and rank the primary factors influencing the total production cost of the oil filter. This method enables a focused

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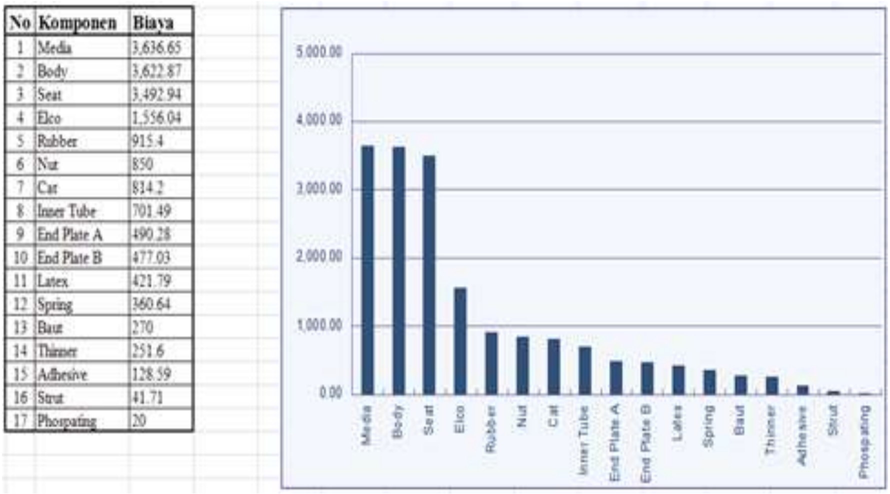
examination of various cost-driving elements, including material type, the number of coils, and wire diameter, allowing manufacturers to pinpoint which components contribute most significantly to overall expenses [14]. Interestingly, although the Endplate-B component is ranked 10th out of 17 items in terms of cost impact, its individual cost remains notably higher than many other components in the assembly. This finding underscores the potential for cost-saving opportunities through design modifications specifically targeting the Endplate-B.



No	Komponen	Biaya
1	Media	3,636.65
2	Body	3,622.87
3	Seat	3,492.94
4	Elco	1,556.04
5	Rubber	915.4
6	Nut	850
7	Cat	814.2
8	Inner Tube	701.49
9	End Plate A	490.28
10	End Plate B	477.03
11	Latex	421.79
12	Spring	360.64
13	Baut	270
14	Thinner	251.6
15	Adhesive	128.59
16	Strut	41.71
17	Phospating	20

Fig. 3: Pareto diagram of cost component

SWOT Analysis

SWOT analysis was conducted to assess the feasibility and strategic implications of redesigning the Endplate-B component, particularly concerning its function within the oil filter bypass valve system. This analysis provides insights into the internal capabilities and external risks associated with implementing design changes:

- **Strengths**: Laboratory test criteria can still be met with a reduced bypass valve height of 15 mm (originally 22 mm). Moreover, the annual order volume for this filter series exceeds 200,000 units, indicating strong market demand [15].
- **Weaknesses**: The decrease in valve height may limit oil flow through the bypass pathway, potentially affecting performance under pressure-sensitive conditions [16].
- Opportunities: The dimensional modification may reduce the likelihood of component interference during assembly, thereby streamlining the manufacturing process [17].
- **Threats**: Original Equipment Manufacturer (OEM) clients might not accept the redesigned Endplate-B, leading to possible delays or rejections [18].

Table 1. Data Sales on 2017 with Endplate-B 22mm

No.	Part Number	Quantity pcs order (year)
1	C-1527	9375
2	C-15271	33225
3	C-15271-V11	1325
4	C-15271-V73	13608
5	C-1527-V1	-
6	C-1527-V11	1425
7	C-1527-V27	-
8	C-1527-V3	8075
9	C-1527-V4	1968
10	C-1535-V3	-
11	C-15670-V73	235200
12	C-1608-V75	2748

According to the annual order data, the highest volume corresponds to part number C-15670-V73, with over 235,000 units. This suggests that optimizing the design of Endplate-B offers significant cost-reduction opportunities. The component can be produced with a 15 mm bypass valve height without changing its diameter or width, while still fulfilling functional and performance requirements.

Redesigning

Following the SWOT analysis, **Fig. 4** illustrates that the prototype of the Endplate-B component features a modified dimension, where the height of the bypass relief valve has been reduced from the original 22 mm to 15 mm.

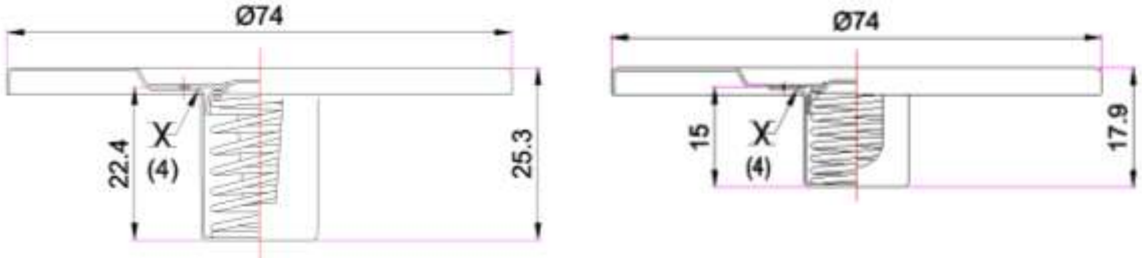


Fig. 4: Comparison between the original (left) and the redesigned (right) Endplate-B.

Relief Valve Performance Test

The relief valve performance evaluation aims to assess the static response and the required activation force of the redesigned valve. This test ensures that the bypass valve opens under standard operating loads without malfunction. The test procedure is as follows:

- Test Configuration: The redesigned Endplate-B with the relief valve is mounted on a test rig that applies incrementally controlled pressure. The pressure is increased in 10 kPa steps, with the oil temperature maintained at 75 ± 3 °C, using ISO VG 100 oil.
- Testing Method: Load is gradually applied to the bypass valve, and the point at which the valve opens is recorded for each pressure level. The test follows the JIS D 1611-1 standard.
- Data Analysis: The opening pressure of the redesigned valve is measured and compared to that of the original design to ensure that it meets or exceeds the required performance standards. The target valve opening pressure is set at 1 ± 0.2 kg/cm².

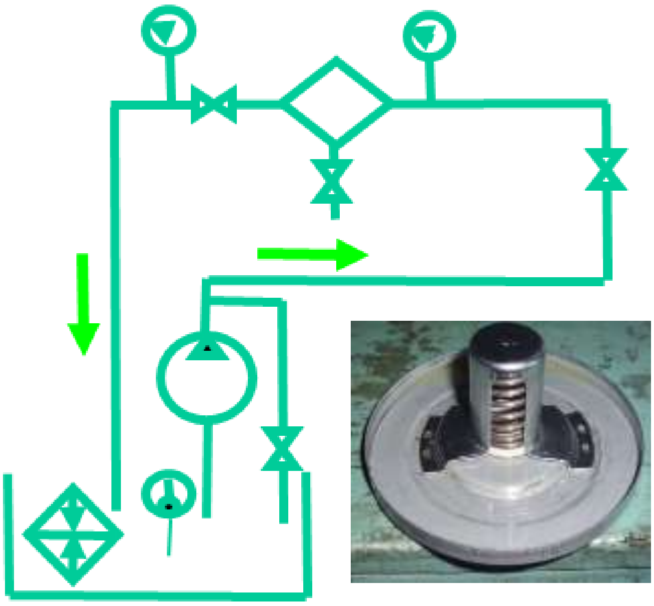


Fig. 5: Loading test diagram procedure

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Fig. 6: Performance test machine

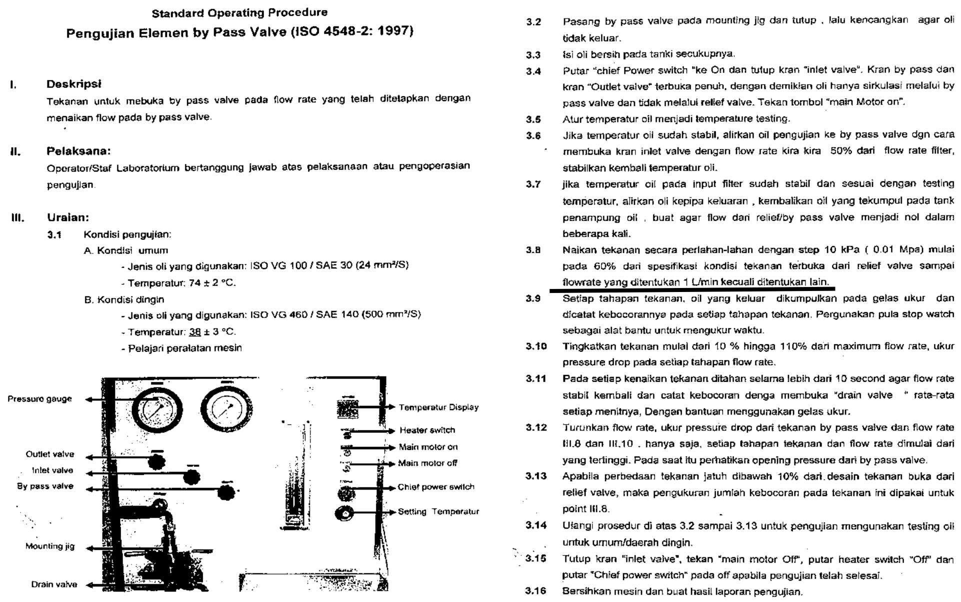
3. Results and Discussion

The comparison between the original and redesigned versions, based on inputs from the SWOT analysis and performance evaluation, serves as the foundation for analyzing the outcomes of both the loading and impulse tests.

Performance Evaluation of the Redesigned Component

The performance assessment of the newly developed endplate-B component was conducted in accordance with laboratory testing standards. As illustrated in **Figure 7**, tests on the original design using 10 samples showed that the bypass valve activated within a pressure range of 1.05–1.2 kg/cm², corresponding to flow rates between 1160 and 1310 ml/min. The results were consistent and displayed a proportional relationship between the applied pressure and the valve response, reflecting stable operational characteristics. Based on this benchmark, the redesigned component was required to achieve similar performance outcomes—namely, activation at a minimum pressure of 1.05 kg/cm² and stable flow behavior.

Figures 7 and **8** indicate that the newly proposed design achieved valve activation within a slightly broader pressure range of 0.9–1.3 kg/cm², delivering flow rates between 1180 and 1310 ml/min. These results confirm that the redesigned endplate-B meets or exceeds the performance standards established by the original configuration, validating the design's functionality through empirical testing.



Standard Operating Procedure
Pengujian Elemen by Pass Valve (ISO 4548-2: 1997)

I. Deskripsi
Tekanan untuk mebuka by pass valve pada flow rate yang telah ditetapkan dengan menaikan flow pada by pass valve.

II. Pelaksana:
Operator/Staf Laboratorium bertanggung jawab atas pelaksanaan atau pengoperasian pengujian.

III. Uraian:
3.1 Kondisi pengujian:
A. Kondisi umum
- Jenis oli yang digunakan: ISO VG 100 / SAE 30 (24 mm²/S)
- Temperatur: 74 ± 2 °C.

B. Kondisi dingin
- Jenis oli yang digunakan: ISO VG 460 / SAE 140 (500 mm²/S)
- Temperatur: 38 ± 3 °C.
- Pelajari peralatan mesin

3.2 Pasang by pass valve pada mounting jig dan tutup , lalu kencangkan agar oli tidak keluar.
3.3 Isi oli bersih pada tanki secukupnya.
3.4 Putar "chief Power switch "ke On dan tutup kran "inlet valve". Kran by pass dan kran "Outlet valve" terbuka penuh, dengan demikian oli hanya sirkulasi melalui by pass valve dan tidak melalui relief valve. Tekan tombol "main Motor on".
3.5 Atur temperatur oil menjadi temperature testing.
3.6 Jika temperatur oil sudah stabil, alirkan oil pengujian ke by pass valve dgn cara membuka kran inlet valve dengan flow rate kira kira 50% dari flow rate filter, stabilkan kembali temperatur oli.
3.7 jika temperatur oil pada input filter sudah stabil dan sesuai dengan testing temperatur, alirkan oli kepipa keluaran , kembalikan oil yang tekumpul pada tank penampung oil , buat agar flow dari relief/by pass valve menjadi nol dalam beberapa kali.
3.8 Naikan tekanan secara perlahan-lahan dengan step 10 kPa (0.01 Mpa) mulai pada 60% dari spesifikasi kondisi tekanan terbuka dari relief valve sampai flowrate yang ditentukan 1 L/min kecuali ditentukan lain.
3.9 Setiap tahapan tekanan, oil yang keluar dikumpulkan pada gelas ukur dan dicatat kebocorannya pada setiap tahapan tekanan. Pergunakan pula stop watch sebagai alat bantu untuk mengukur waktu.
3.10 Tingkatkan tekanan mulai dari 10 % hingga 110% dari maximum flow rate, ukur pressure drop pada setiap tahapan flow rate.
3.11 Pada setiap kenaikan tekanan ditahan selama lebih dari 10 second agar flow rate stabil kembali dan catat kebocoran denga membuka "drain valve " rata-rata setiap menitnya, Dengan bantuan menggunakan gelas ukur.
3.12 Turunkan flow rate, ukur pressure drop dari tekanan by pass valve dan flow rate III.8 dan III.10 . hanya saja, setiap tahapan tekanan dan flow rate dimulai dari yang tertinggi. Pada saat itu perhatikan opening pressure dari by pass valve.
3.13 Apabila perbedaan tekanan jatuh dibawah 10% dari desain tekanan buka dari relief valve, maka pengukuran jumlah kebocoran pada tekanan ini dipakai untuk point III.8.
3.14 Ulangi prosedur di atas 3.2 sampai 3.13 untuk pengujian mengunakan testing oil untuk umum/daerah dingin.
3.15 Tutup kran "inlet valve", tekan "main motor Off", putar heater switch "Off" dan putar "Chief power switch" pada off apabila pengujian telah selesai.
3.16 Bersihkan mesin dan buat hasil laporan pengujian.

Fig. 7: Standard Operational Procedure of Performance test lab

Fig. 8: Report of performance test on old design (left) and new design (right)

Material Cost Reduction Impact

The design modification resulted in a notable material cost saving of approximately 11.06%. The Bill of Materials (BOM) for the initial design was recorded at Rp. 449.84 per unit, while the redesigned version reduced this figure to Rp. 400.07, resulting in a cost saving of Rp. 49.77 per unit. This reduction was achieved despite using the same material, by optimizing the geometry—specifically, reducing the height of the bypass valve—which contributed to lower raw material consumption by approximately 11%.

From a production standpoint, this cost-saving measure has significant implications. The previous version of the endplate-B component was employed in high-demand oil filters. Based on 2017 sales data, for one part number with an annual sales volume of 33,225 units, the estimated cost reduction totaled Rp. 1,653,774. When considering all associated part numbers using this component, with an annual volume of 306,949 units, the total potential savings amounted to Rp. 15,278,383. Additionally, this cost optimization led to a shift in the BOM cost ranking for endplate-B from 10th to 11th out of 17 components, reflecting improved cost efficiency.

4. Conclusion

This research focused on redesigning the endplate-B component used in oil filter bypass valve systems with the goal of reducing material costs while maintaining performance integrity. Although the Pareto diagram analysis revealed that endplate-B was not the primary contributor to overall manufacturing cost, it still ranked 10th out of 17 cost drivers, indicating a worthwhile opportunity for improvement. A relatively minor design change—reducing the height of the bypass relief valve from 22 mm to 15 mm—resulted in measurable material savings across all filters utilizing this component.

The design revision process was guided by SWOT analysis, which outlined key factors affecting the feasibility of the redesign. Strengths included the achievement of laboratory performance standards with the modified valve dimensions and a high annual production volume, making the redesign economically viable. Potential weaknesses, such as reduced oil flow, and threats such as possible resistance from OEM customers, were also acknowledged and addressed during evaluation.

Performance validation was conducted through a series of impulse and load tests to ensure that the redesigned component retained its functional reliability. The results confirmed that the new configuration met the same operational standards as the original design, with bypass activation occurring consistently within the pressure range of 0.9–1.3 kg/cm² and flow rates between 1180 and 1310 ml/min, aligning with the benchmark set by the older version.

From a cost perspective, the redesign achieved an 11.06% reduction in material expenses, decreasing the bill of materials from Rp. 449.84 to Rp. 400.07 per unit. Based on historical sales volumes, this translates into annual savings of over Rp. 15 million across multiple part numbers. Furthermore, the cost ranking of endplate-B in the component list improved, demonstrating enhanced cost efficiency.

In conclusion, the redesign of the endplate-B component offers a practical example of how targeted modifications, supported by analytical tools and testing, can yield substantial financial benefits without sacrificing product performance. This study contributes to the broader field of cost-effective engineering by illustrating how systematic design review can optimize component value, particularly within the automotive manufacturing sector.

5. Acknowledgment

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