

PROGRAM

Opening Ceremony

The 18th Asian International Conference on Fluid Machinery (AICFM18)

Venue: Vinpearl Resort & Spa Ha Long, Reu Island, Quangninh, Vietnam.

Time: October 2nd, 2025

Time	Activity
08:30 – 09:00	Welcome Delegates & Registration (Location: Main Lobby)
09:00 – 09:15	Opening Remarks by Conference Chair (Location: Event Hall)
09:15 – 09:30	Speech by the Representative of the Asian Fluid Machinery Committee
09:30 – 11:55	PLENARY SESSION (Location: Event Hall)
09:30 – 09:55	Topic: "Flow Analysis and Optimization Design of Reversible Pump-Turbines" Speaker: Prof. BAOSHAN ZHU Affiliation: Department of Energy and Power Engineering, Tsinghua University, China
09:55 – 10:20	Topic: "Economic and Environmental Assessment of a Solar-Wind-Biomass Hybrid Renewable Energy System for Electricity and Hydrogen Production: A Case Study of Ly Son Island" Speaker: Prof. BUI VAN GA Affiliation: General Editor of the University of Danang - Journal of Science and Technology (UD-JST)
10:20 – 10:40	Tea-break & Networking
10:40 – 11:05	Topic: "Analysis and Design optimization of casing treatments for axial compressors" Speaker: Prof. KWANG-YONG KIM Affiliation: Department of Mechanical Engineering, Inha University, Korea
11:05 – 11:30	Topic: "Internal flow and flow instability in hydro turbine draft tubes and countermeasures" Speaker: Prof. KAZUYOSHI MIYAGAWA Affiliation: Faculty of Science and Engineering, Waseda University in Tokyo, Japan
11:30 – 11:55	Topic: "Research on Integrated Equipment for Emergency Water Supply and Purification in Mountainous and Remote Disaster Areas" Speaker: Prof. SHOUQI YUAN Affiliation: Chairman of the Asian Fluid Machinery Committee (AFMC), Jiangsu University, China
11:55 – 12:10	Discussion & QA
12:10 – 13:30	Lunch (Location: Bay view Restaurant)

DAY 2 - OCTOBER 3, 2025 - EVENT HALL 02

Fans, Blowers, and Compressors (Part 3)		
08:30 - 10:15	Paper ID	Chair: Dr. Van Bo Nguyen, Institute of High-Performance Computing (IHPC), Agency for Science, Technology and Research, Singapore
08:30 - 08:45	879	Research and Evaluation of the Efficiency of the Method of Manufacturing Axial Fans Using Centrifugal Casting Technology Vu Dinh Dang, Minh Tuan Nguyen, and Van Xo Nguyen
08:45 - 09:00	894	Numerical Study of the Relationship between the Hub-to-Tip Diameter Ratio and the Performance of Steam Centrifugal Compressors in a Two-Stage MVR System Jun-Beom Kim, Hyeon-Mo Yang, Kyong-Yong Lee, Joon-Yong Yoon, and Young-Seok Choi
09:00 - 09:15	950	Research on the Impact of a Curved Volute Fan on the Performance of an Integrated Air Duct System Yanpeng Ma, Xiaokang Peng, Jiwu Jiang, Meng Hao, and Xiaomin Liu
09:15 - 09:30	952	Study on the Effects of the Structure of the Mesh Cover on the Aerodynamic Performance of a Fan Wu Xianpeng, Liu Xiaomin, Wei Lai, Luo Dan, and Kang Ruixiang
09:30 - 09:45	988	Numerical Aeroacoustic Characteristics of an electric Ducted Propulsion Fan with Surface Roughness Numerical Aeroacoustic Characteristics of an Electric Ducted Propulsion Fan with Surface Roughness G.D. Pham, T.D. Nguyen, H.Q. Chu, B.N. Nguyen, T.S. Vu, V.D. Vu, T.K. Nguyen, D.A. Le, T.H. Tran, X.G. Nghiem, and C.T. Dinh
09:45 - 10:00	989	Advanced Experimental and Computational Investigation of Rotor Dynamics in Axial Compressors: A Comparative Study on Aluminum 7050 and Titanium Ti-6Al-4V Nhat Minh Hoang, Minh Duc Ha, and Cong Truong Dinh
10:00 - 10:15	1000	CFD-Based Performance Prediction and Blade Count Optimization for a High-Pressure Centrifugal Fan with Perpendicular Blade Geometry Toan Van Nguyen, Quyen Duc Vu, Huy Chuong Tran, Duc Xuan Vu, Manh Duc Nguyen, Manh Hung Nguyen, and Sang Truong Ha
10:15 - 10:30		Tea-Break
Tribology, Seals and Bearings (Part 4)		
10:30 - 12:15	Paper ID	Chair: Prof. Ich Long NGO, Hanoi University of Science and Technology, Vietnam
10:30 - 10:45	795	Research on Evaluating the Braking Efficiency of 1.25-Ton Trucks on Nonlinear Bumpy Roads Danh Nguyen Thanh, Phat Khau Tan, and Huu Vo Trong
10:45 - 11:00	868	Design of a Shaft Sealing Test Bench Qinzhao Zhang and Hong Wang
11:00 - 11:15	881	Dynamic Characteristics of a Thrust Bearing in a 300 MW Suspended Pumped Hydroelectric Generator: A Numerical Investigation of Two Models Shenming Ren, Yuan Zheng, Kui Tang, and Yuquan Zhang
11:15 - 11:30	887	Deepwater X-Tree Spring Seal Structure Design and Seal Performance Analysis Zhang Hong, Long Shengjun, Huang Yi, Feng Ding, Lin Yaojun, Wang Gaolei, and Liu Kuo
11:30 - 11:45	890	Reliability and Lifetime Evaluation of Metro Train Wheelsets Due to Wear and Tear in Operation on the Cat Linh - Ha Dong Line Toan Duc Nguyen and Tuan Duc Do
11:45 - 12:00	896	Reliability Evaluation of the Crankshaft Bearing System in D19E Locomotive Engines Used in Vietnam Railways Hieu Van Tran, Tuan Duc Do, and Toan Duc Nguyen
12:00 - 12:15	932	Effect of Gas Nitriding on the Surface Properties of Titanium Trung Trinh Van and Trang Dang Huyen
12:15 - 13:30		Lunch

Trả lời: UFMS procedure (ID 879) Tóm tắt email này

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Print Name:

Vu Dinh Dang

Date:

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Address:

Hanoi University of Mining and Geology, Hanoi, Vietnam

Email:

dangvudinh@humg.edu.vn

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RESEARCH AND EVALUATION OF THE EFFICIENCY OF THE METHOD OF MANUFACTURING AXIAL FANS USING CENTRIFUGAL CASTING TECHNOLOGY

Vu Dinh Dang^{*1}, Minh Tuan Nguyen¹, Van Xo Nguyen¹

1 - Hanoi University of Mining and Geology, 18 Vien Street, Ha Noi, Vietnam

ABSTRACT

In this study, we will discuss the axial fan used in automobile cooling systems. Previously, this type of fan was often manufactured by injection molding, mechanical processing or heat pressing. However, material technology has developed with a variety of types to ensure technical requirements for durability and reasonable price. Therefore, it is necessary to consider and improve the method of manufacturing details and parts of the fan. Centrifugal casting technology was developed in the 1950s. This is a completely different casting method compared to traditional casting methods. Centrifugal casting technology is an innovative method that allows the creation of thick and hollow blades. With this method, costs are reduced and manufacturing is relatively easy. To evaluate the effectiveness of fans manufactured by this method, the study used an aluminum reference fan with similar geometric dimensions. The fans were aerodynamically tested on a standard test bench 5801. Research results show that the characteristic curves obtained for the two fans tend to be similar, which shows the adaptability and potential of this type of fan. Besides, at the design point $\phi = 0.13$, the efficiency difference between the fan manufactured by centrifugal casting method and the reference fan is about 3.1% at a rotation speed of 2000 rpm. The kinetic powers of the centrifugal casting fan was reduced by about 3%, while the mechanical power was reduced by almost 10% compared to the reference fan. This has great significance in terms of manufacturing technology, as well as the hollow fan characteristics it brings.

Keywords: Axial fan, Centrifugal casting, hollow fan, Efficiency, Automobile.

**Corresponding author: Vu Dinh Dang
E - mail: dangvudinh@humg.edu.vn*

1. INTRODUCTION

In the current period, the automobile industry is developing strongly with many different manufacturers, along with the trend of shifting to the source of driving energy. Therefore, more and more applied research in this field is related to the issue of productivity, efficiency, cost and application of new production methods. In particular, axial fan blades used in automobile cooling systems are currently being expanded research. Previously, the axial fan used in this system was mainly manufactured by injection molding, mechanical processing or heat pressing. However, the plastic market is currently relatively developed, with many suppliers, which brings the advantage of low cost, popularity and easy access. From there, research and improvement of manufacturing methods for parts and components are being focused on. The new solution to replace the axial fan manufacturing method is centrifugal casting technology [1,2]. This technology was developed in the 1950s, which is a method to create hollow parts from simple to complex without welding seams [3-5]. Currently, there are two populars centrifugal casting methods: conventional centrifugal casting method and reaction centrifugal casting method [6]. This study deals with the conventional centrifugal casting method to manufacture axial fans. Basically, centrifugal casting technology is only suitable for simple parts, without many corners, large space inside the mold... But with this manufacturing method, especially parts with complex structures such as axial fans, it is a challenge and requires many experimental studies to select the optimal set of manufacturing parameters. The purpose of this study is to manufacture and evaluate axial fan versions, applied in automotive cooling systems to improve performance, noise, etc. Typically, axial fans allow the use of thin blades, but in order to manufacture the fan by centrifugal casting, the blade thickness must be relatively large (≥ 10 mm) [7, 8]. To evaluate the efficiency of the centrifugal casting process, fan samples will be manufactured, which will then be tested on the ISO5801 standard test bench [9] to determine the aerodynamic properties of the resulting fans. In addition, to compare the aerodynamic properties of the centrifugally cast fan, an aluminum fan with the same geometrical parameters was fabricated (this fan only differs in the manufacturing method). The aluminum fan used in this study is considered as the reference fan.

2. RESEARCH CONTENT

2.1 Introduction to centrifugal casting technology for manufacturing axial fans

The fan manufacturing process is carried out in the PIMM (Procédés et Ingénierie en Mécanique et Matériaux) laboratory. This is a LAB 40 centrifugal casting machine of the Suttle type from STP. The machine is equipped with a computer screen that allows setting the operating parameters of the casting process (Fig. 1). The

parameters to be adjusted during the casting of the fan include as follows: temperature, time in the oven, mass of casting material, mold cooling time, manufacturing material, etc.

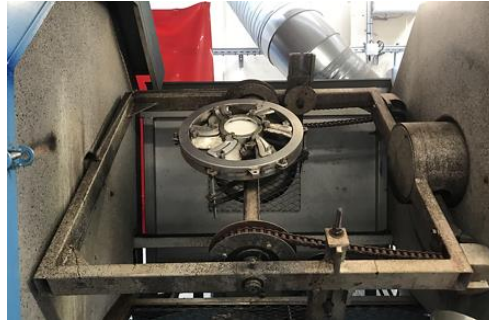


Fig. 1. Centrifugal casting machine

The centrifugal casting process consists of four main steps (Fig. 2): 1 - Filling the mold with powder; 2 - Heating the rotating mold in the oven; 3 - Cooling the rotating mold; 4 - Finishing the casting impeller. The mold is placed on two perpendicular rotating shafts, the rotational speeds of the two shafts are independent and can be customized. This allows flexibility when producing complex shaped castings or products requiring high quality. Typically, the rotational speed is kept constant during the heating process in the oven and the cooling process.

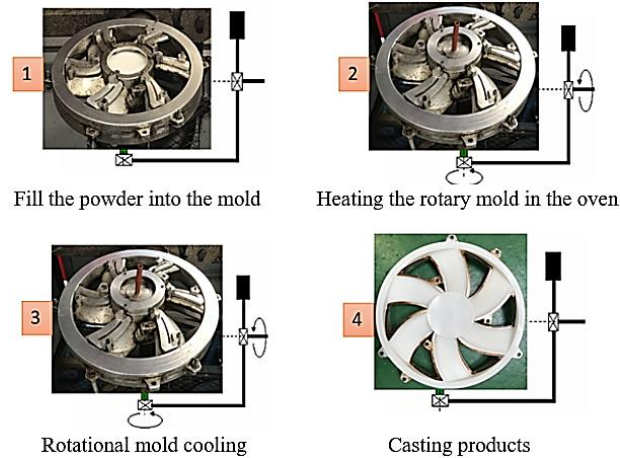


Fig. 2. Steps of the fan casting process

The main advantage of this manufacturing technology allows the creation of thick and hollow blades. This characteristic gives the blades useful advantages that cannot be achieved by other conventional manufacturing methods (Fig. 3).



Fig. 3. Cross section of fan (hollow fan)

2.2 Select some parameters of the centrifugal casting process.

The effects of factors related to the centrifugal casting process studied: powder mass, temperature and heating time in the oven. During the manufacturing process of the fan blade, if the heating time or temperature is not enough, the polymer will not melt completely, the air bubbles will not dissolve. This reduces the hardness of the resulting fan blade. On the other hand, if the heating time or temperature is too high, the material will degrade, change color and the fan blade will become brittle and fragile. The powder mass also affects the quality of the fan blade: such as thickness, durability, etc. In addition, if we pour too much powder into the mold, it can lead to the powder not being able to move in the mold (due to being squeezed or too little space), the shape of the fan blade is uneven due to lack of powder, etc. Therefore, in this study we will consider the factors (powder mass, oven temperature, time in the oven, etc.):

Fan manufacturing code: **PEL - m - T_h - Δt_h**

- PE material used is polyethylene.

- Material mass $m = 500$, g

- Oven temperature: $T_{oven} = (250; 285; 330)$, °C

- Heating time in the oven: $\Delta t_{\text{oven}} = (12; 15; 20)$, min
- Mold cooling method: cooling by fan for 20 min

2.3 Characteristics of fan materials.

Currently, polyethylene (PE) accounts for about 90% of all polymers used in centrifugal casting. The basis for selection is PE's ability to withstand high temperature environments, long process times and especially its relatively low cost. Polyethylene is generally resistant to water, vegetable oils, alkalis and most concentrated acids at room temperature.

Table 1. Volume density of PE

Material Type	Volume density (kg/cm ³)
Low Density Polyethylene (LDPE)	915 ÷ 929
Medium Density Polyethylene (MDPE)	930 ÷ 939
High Density Polyethylene (HDPE)	940 ÷ 965

In this study, we used polyethylene powder (LDPE-3200) provided by ICO Polymer Factory. This powder has a melting point of 3.3g/10 min, a density of 938 kg/m³ and a particle size range of 125÷250 μm .

2.4 Reference fan

To determine the dynamic and aerodynamic parameters of the fans manufactured by centrifugal casting technology, an aluminum fan was considered as a reference fan. These two fans were manufactured with the same geometrical dimensions and differed only in the manufacturing process, (see Fig. 4).



Fig. 4. The fan produced by centrifugal casting and reference fan

2.5 Introduction of axial fan aerodynamic test bench

This standard test bench is shown in figure 5, designed and built by LIFSE laboratory according to ISO 5801 [11], it is a box with dimensions of 1.3 x 1.3 x 1.8m. The air flow is measured according to ISO 5167 [12], by changing the inlet diameter d (mm). In this study, the diameter d (mm) is used with 11 different sizes, Table 2. The system is driven by a 4kW motor. A torque sensor (HBM T20WN) with an accuracy of $\pm 0.2\%$ is mounted between the fan shaft and the motor shaft.

Table 2. Diameter of suction diaphragm d

d (mm)										
121	135	169	190	220	238	267	300	336	375	475

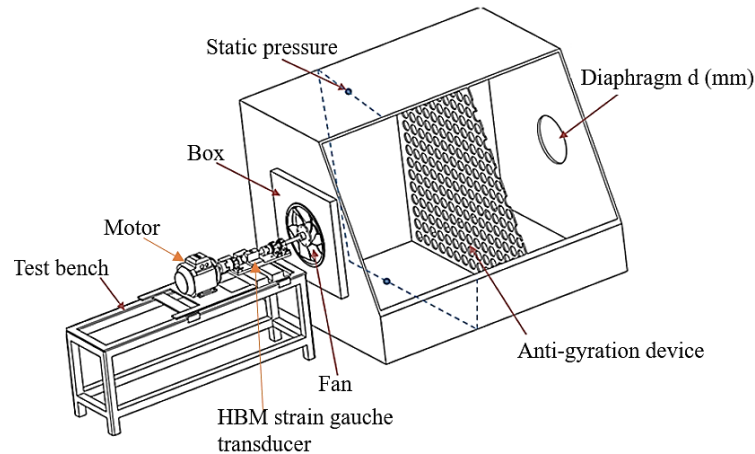


Fig. 5. Fan aerodynamic characteristics test bench

Static pressure Δp is measured at 4 holes arranged around the box with absolute accuracy $\pm 0.1 \text{ Pa}$. A perforated plate with a diameter of 50 mm and a thickness of 10 mm is placed inside the box to avoid the vortex phenomenon of the gas flow. The gas flow rate Q_v is determined by formula (1):

Low rate Q_v (m^3/s):

$$Q_v = \alpha * A * \sqrt{\left(\frac{2 * \Delta p}{\rho_{kk}}\right)} = 0,6 * \left(\frac{\pi * D^2}{4}\right) * \sqrt{\left(\frac{2 * \Delta p}{1,21}\right)} \quad (1)$$

- α - coefficient ($\alpha = 0.6$)
- A - cross section, m^2
- Δp - static pressure, Pa
- ρ_{kk} - density of air, kg/m^3

Dynamics power P_{dh} (kW):

$$P_{dh} = \Delta p * Q_v \quad (2)$$

Mecanical power P_{ck} (kW):

$$P_{ck} = (U * I) - (r * I^2) - (U_0 * I_0 - r * I_0^2) \quad (3)$$

- U_0 - voltage when rotor is no-load, V
- I_0 - no-load rotor current, A
- r - rotor resistance, Ω

Mechanical power consists of three elements:

- $(U * I)$ - electric power
- $(r * I^2)$ - joule loss
- $(U_0 * I_0 - r * I_0^2)$ - rotor loss at no-load operation

Dynamic efficiency η (%):

$$\eta = \frac{P_{dh}}{P_{ck}} = \frac{\Delta p * Q}{(U * I) - (r * I^2) - (U_0 * I_0 - r * I_0^2)} \quad (4)$$

Low coefficient (ϕ) and pressure coefficient (ψ) determined with respective errors of $\pm 0.5\%$ and $\pm 0.3\%$

Low coefficient ϕ :

$$\phi = \frac{Q_v}{\pi * \omega * R_{max}^3} \quad (5)$$

Pressure coefficient ψ :

$$\psi = \frac{2 * \Delta p}{\rho * \omega^2 * R_{max}^2} \quad (6)$$

3. RESULTS AND DISCUSSION

3.1 Check the repeatability of the fan manufacturing process

To test the repeatability of the manufacturing process, we have manufactured 3 fans with the same code PEL-500-250-12. The manufacturing conditions must ensure the following criteria: The temperature in the oven must be stable before the mold is placed in the oven; the same method of filling the powder into the mold; Manufacturing the fans at different times. The manufacturing results are shown in Fig. 6, through observation we can see that the 3 fans obtained do not have any significant differences such as shape, color, or defects on the fan blades. This shows that the repeatability of the manufacturing results is reasonable and ensures reliability.



Fig. 6. The fans are manufactured with the same code PEL-500-250-12

3.2 Check the repeatability of the measurement process on the test bench

For each measuring points, the number of samples is recorded in 180 seconds, the sampling frequency is 1000Hz, the number of samples equivalent to each measuring point is 18000 points. In Fig. 7, the static pressure value in the box and the torque value on the motor shaft at the rotation speed $N = 2000 \text{ r/min}$ are shown. These values are collected by the FCO318 pressure sensor and the HBM T20WN torque sensor (measuring range 5 N.m,

accuracy $\pm 0.2\%$). The values obtained from the pressure sensor and torque sensor are displayed in the form of voltage (V) and current (A), these signals will be connected to the computer and Labview software through the Ni Card to convert the electrical signal to a digital signal. The results obtained show that these values relatively stable. The measured sample values are distributed relatively symmetrically around the average value. This shows that the obtained values can be guaranteed to be reliable, however, to confirm further certainty, it is necessary to consider the repeatability of the measured values.

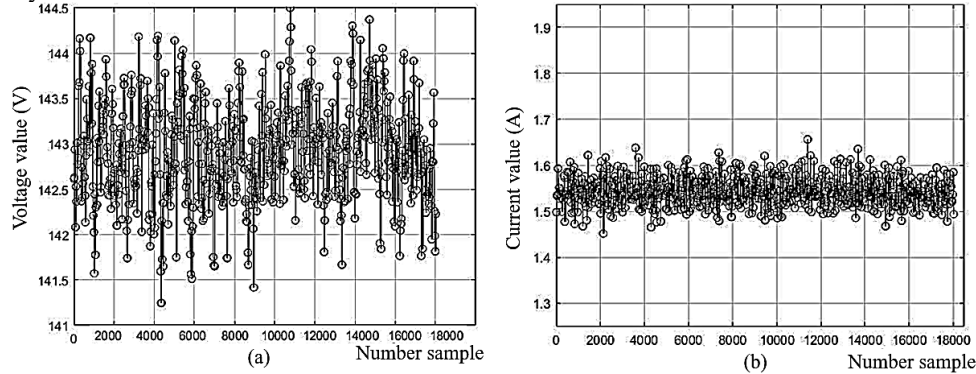


Fig. 7. Number of samples determined in 180 seconds

(a) - pressure measurement value, (b) - torque measurement value

To ensure the accuracy and reliability of the measurement results. A study of the repeated measurement of the aerodynamic parameters of the fan on the test bench was carried out. This will verify that the tests give repeatable results. We randomly selected one of the three fans with the code PEL-500-250-12 that were manufactured as mentioned above conducting the measurement. The test was carried out at least three times and the measurement process must be ensured: between each measurement the fan was disassembled, reassembled and measured at different times. Fig. 8 (a), (b) shows that the test results at the fan speed $n = 2000$ r/min are almost identical between measurements, the curves of pressure and efficiency values compared to flow values are perfectly re-established, with regularity. There is a slight difference in the efficiency values, however these values are within the measurement error range of $\pm 5\%$, Table 3.

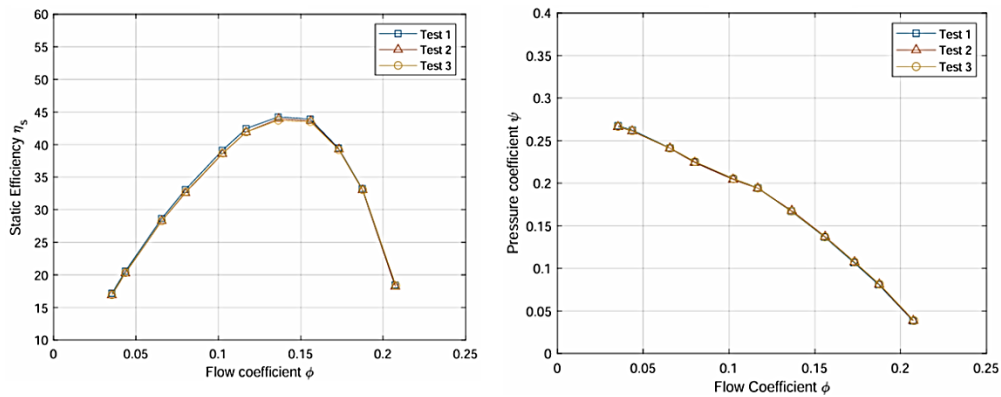


Fig. 8. Relationship between static efficiency, pressure coefficient and flow coefficient at rotation speed $n = 2000$ r/min

Table 3. Repeatability test results of fan measurement on test bench with manufacturing code PEL-500-250-12

Test	Pressure (Pa)	Air flow (m ³ /s)	Efficiency (%)
Test 1	139,55 $\pm$ 0,6	0,5144 $\pm$ 0,005	44,23 $\pm$ 0,5
Test 2	140,63 $\pm$ 0,6	0,5154 $\pm$ 0,005	43,95 $\pm$ 0,5
Test 3	139,94 $\pm$ 0,6	0,5145 $\pm$ 0,005	43,71 $\pm$ 0,5

3.3 Results of manufacturing and testing fan aerodynamic characteristics

In this study, we tested the fabrication of a fan with a powder mass of 500 g, with manufacturing parameters with detailed manufacturing codes in Table 4. By changing the manufacturing parameters such as the temperature in the oven, the molding time in the oven, the image of the fan is shown in Fig. 9. The manufacturing results show the adaptability of the fan blade to this manufacturing method. However, we see that the color of the fan is not uniform (the transparency of the material and the color of the fan change when the temperature is high). Specifically: When the temperature in the casting oven is greater than 285 °C and the time in the oven is 15 minutes, we see a significant change in the color of the fan and the fan blade becomes yellower. This can be explained by the oxidation of the material. When oxidation occurs, the fan loses its flexibility and increases its resistance and hardness, and eventually the fan blade becomes more brittle.

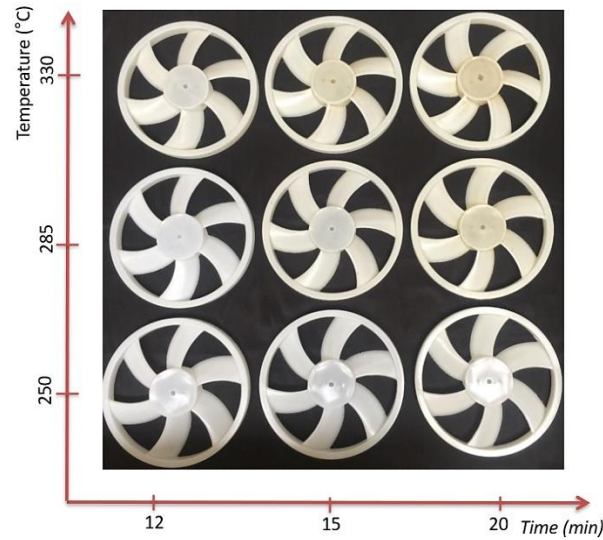


Fig. 9. Image of fan manufactured by centrifugal casting technology with a mass of 500g

On the aerodynamic test bench, the fan manufactured by centrifugal casting technology (manufacturing code: PEL - m - T_{10} - Δt_{10}) and the reference fan were measured. Due to the hollow nature of the fan and the PEL powder, to avoid deformation (imbalance) of the fan blades when rotating at high speed, different speed ranges were tested: 1000, 1500 and 2000 rpm. This allowed to evaluate many different aspects between the centrifugal casting fan and the reference fan: assessment of the adaptability of the manufacturing method, stability at different speeds, efficiency values, etc. The measurement results are shown in Table 4 at the fan speed $N = 2000$ rpm.

Table 4. Measurement results at speed $N = 2000$ rpm

Manufacturing code	M [g]	T [°C]	T [min]	ϕ	Ψ	η [%]
PEL-500-250-12	500	250	12	0.1403	0.1656	43.82±0.5
PEL-500-250-15	500	250	15	0.1431	0.1610	43.76±0.5
PEL-500-250-20	500	250	20	0.1431	0.1603	44.44±0.5
PEL-500-285-12	500	285	12	0.1445	0.1581	43.93±0.5
PEL-500-285-15	500	285	15	0.1410	0.1636	43.17±0.5
PEL-500-285-20	500	285	20	0.1403	0.1643	44.12±0.5
PEL-500-330-12	500	330	12	0.1417	0.1619	44.04±0.5
PEL-500-330-15	500	330	15	0.1410	0.1636	43.74±0.5
PEL-500-330-20	500	330	20	0.1417	0.1626	45.43±0.5
Reference fan				0.1380	0.1710	42.35±0.5

The test results show the feasibility of centrifugal casting technology, the performance values obtained from 9 fans are almost similar. This shows that the approach of centrifugal casting technology to manufacture axial fans for application in automobile cooling systems is feasible. However, these are only the research stages, as well as the first experimental fan versions manufactured. Therefore, to optimize the manufacturing technology, further in-depth research is completely capable of improving the quality as well as the performance value of this type of fan. In addition, the hollow nature of the fan blade obtained is also a special advantage, especially the ability to absorb sound.

In Fig. 10, the graph shows the relationship between the efficiency value, the pressure coefficient with the flow coefficient at the fan speed ranges: 1000, 1500 and 2000 rpm. We can see that the largest efficiency difference at 2000 rpm of the reference fan with the fan with the highest efficiency code PEL-500-330-20 is 3.1%. Meanwhile, the efficiency obtained the other fan larger than the reference fan (Table 4). This analysis result seems to be very consistent with the evaluation of the fan manufacturing process when changing the parameters (temperature and heating time in the oven), the color of the obtained fan changes significantly. This can be explained based on the oxidation of the fan blade. At a temperature of $T = 330$ °C and a mold time in the oven of about $t = 20$ min, the phenomenon of material oxidation may have been formed and this leads to the phenomenon of the fan becoming harder than other manufacturing conditions. Therefore, when the fan blade rotates at high speed, the ability to resist deformation of this fan blade is greater, making the flow velocity around the blade cross-section stable and the efficiency higher. However, when oxidation occurs, the color of the fan becomes yellower, brittle and fragile, leading to a decrease in practical application.

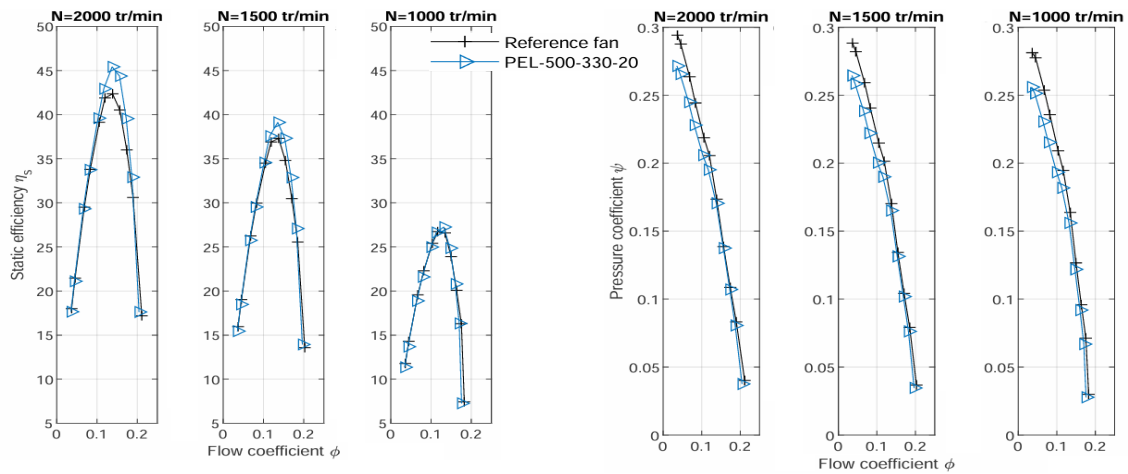


Fig. 10. The graph shows the relationship between efficiency, pressure coefficient and flow coefficient of two PEL-500-330-20 fans and the reference fan.

The research results show the potential of manufacturing cooling fans using centrifugal casting technology as well as the outstanding feature of the hollow nature of the fan. Specifically, we see that the aerodynamic power value of the centrifugal casting fan compared to the reference fan is reduced by about 3% but the mechanical power value is reduced by nearly 10% compared to the reference fan, Table 5.

Table 5. Comparison of performance of reference fan and centrifugal casting fan at rotation speed $N = 2000$ rpm

TT	Parameter names	Reference fan	Centrifugal casting fan	Unit of measure
1	Efficiency	$42,35 \pm 0.5$	$45,4 \pm 0.5$	%
2	Torque	$0,85 \pm 0.003$	$0,76 \pm 0.003$	N.m
3	Aerodynamics power	74,90	72,4	W
4	Mechanical power	176,8	159,3	W

4. CONCLUSION

The research results have mentioned some aspects as follows:

➤ The research has proposed a new method in the field of manufacturing axial fan blades by centrifugal casting method. The research results show the adaptability of fan blades manufactured by centrifugal casting technology. The obtained fan dynamic characteristics are almost similar to the reference fan.

➤ In terms of driving energy, the mechanical power of the centrifugal casting fan is reduced by about 10% compared to the reference fan. In addition, the efficiency values of the obtained fan blades are all larger than the reference fan and the maximum efficiency value increases by about 3.1% with the PEL-500-330-20 fan at a rotation speed of 2000 rpm.

➤ To improve the quality of axial fan blades manufactured by centrifugal casting method, more in-depth studies are needed such as: determining the deformation when rotating at high speed, fan balance, fan shrinkage, or testing with different powder masses (300 g, 400 g, and 600 g) □

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