Technological Applied Sciences
ISSN: 1308 7223
Article ID: 2A0210

Status : Research Article
Received: 02.07.2025
Accepted: 20.10.2025

İhsan Kırık
Bingöl University, alihsankirik@gmail.com, Bingöl-Türkiye

DOI	http://dx.doi.org/10.12739/NWSA.2025.20.4.2A0210
ORCID ID	0000-0002-8361-319X
Corresponding Author	İhsan Kırık

COOLING OF V-BELTS USED IN CAST PULLEYS: INVESTIGATION OF THE EFFECTS OF MATERIALS AND GEOMETRIC SHAPES ON COOLING RATES AND BELT LIFESPANS

ABSTRACT

This study investigates the effects of materials and geometries used in cast V-belt pulley mechanisms on their operational efficiency. The material and production process of the cast V-pulley closely determine the working life of the belts. Minimizing operating costs can be achieved by producing high-quality pulleys and increasing the expected service life of the belts. Conversely, belts may wear out and reach the end of their lifespan or break prematurely. Negative pulley issues and belt breakage can result in high costs. V-pulleys are largely produced using casting methods. These methods generally utilize different casting techniques such as sand casting, metal casting, and die casting. Many metals and alloys (Al, Fe, Mg, and their alloys) can be cast as materials for pulley production. The chemical structure, content, and geometric structure of the cast pulley material are the most important factors affecting its service life and efficiency.

Keywords: Belts And Pulley Systems, V-pulley, Pulley Geometry, Pulley Materials, Pulley Efficiency

1. INTRODUCTION

Belts and pulleys, which play an important role in many different industrial sectors, enable both speed reduction and more efficient and safer power transmission. Belt and pulley systems operate more safely and efficiently than gear, chain, and sprocket systems used for speed reduction [1, 2, 3, 4 and 5]. Belt and pulley systems are machine parts that transmit power via a belt and are an indispensable part of mechanical systems. Belt pulleys transmit power through a belt. These pulleys are generally designed in a circular or toothed shape. They are mounted on the belt and, by receiving the belt's movement, transmit power to the relevant mechanism. There are many industries and applications where belt pulley systems are used [6 and 7]. Furthermore, much research has been conducted on the efficiency of belt pulley systems. In conveyor systems, belts driven by pulleys are used to transport materials. In pump systems, belts transmit the rotational movement of the motor to the pump, enabling the movement of fluids [8]. In drilling, milling, and machining equipment, pulleys transmit the motor's movement to the cutting tools, allowing the machining of workpieces [9, 10, 11 and 12]. In automobiles, belt-pulley systems are used to transfer the engine's movement to different components. Agricultural machinery requires belt-pulley systems to transfer engine power to other equipment [13]. Furthermore, belt-pulley systems are widely used for power transmission in machines designed for various industrial applications [14]. Belt pulley systems offer cost-effective and efficient power transmission. They also have many advantages, such as low maintenance requirements, quiet operation, and easy installation. However, to maximize the performance and lifespan of these systems, belt

How to Cite:
Kırık, A., (2025). Cooling of v-belts used in cast pulleys: investigation of the effects of materials and geometric shapes on cooling rates and belt lifespans. Techonological Applied Sciences, 20(4):101-106, DOI: 10.12739/NWSA.2025.20.4.2A0210.

tension and friction should be regularly checked and adjusted as needed. Belt pulley systems are standardized and categorized into different types according to their application and function [15].

2. RESEARCH SIGNIFICANCE

The aim of this study to investigate the effects of materials and geometries used in cast V-belt pulley mechanisms on their operational efficiency. The material and production process of the cast V-pulley closely determine the working life of the belts.

Highlights:

- Minimizing operating costs can be achieved by producing high-quality pulleys and increasing the expected service life of the belts.
- Conversely, belts may wear out and reach the end of their lifespan or break prematurely.
- Many metals and alloys (Al, Fe, Mg, and their alloys) can be cast as materials for pulley production.

3. THE MAIN TYPES OF BELT PULLEYS USED TODAY ARE AS FOLLOWS:

- Classic V-type belt pulley systems
- Timing belt pulley systems
- Polyv pulley belt systems
- Flat belt pulley systems
- Rope pulley systems
- Variable belt pulley systems

3.1. Classic V-Type Belt Pulley Systems

The primary parts of a belt pulley system are the V-belt and V-belt pulleys, also called grooved pulleys. They offer crucial contact or friction surfaces that allow torque to be transferred from the drive pulley to the driven pulley. The side surfaces of the trapezoidal cross-section of the belt provide the required surface/contact pressure on the side walls of the V-belt pulley grooves, thanks to the pre-tensioning force applied to and adjusted on the belt. They are favored when there is very little belt slippage on the pulley during power transmission.

Figure 1. Classic V-Type Belt Pulley Systems [16]

3.2. Timing Belt Pulley Systems

Timing belts, manufactured with two different tooth profiles – round and trapezoidal – are used where synchronization and positioning between power-transmitting shafts are important. Round profile pulleys are used where torque is required, while trapezoidal profile pulleys are used where more precise linear positioning is necessary. The choice of profile shape and size depends on the power and speed curve of the system, as with classic V-belts. Generally, servo or stepper motors are used as the drive element in such systems.

Figure 2. Timing Belt Pulley Systems [17]

3.3. Polyv Belt Pulley Systems

They have a structure like the classic V-belt pulley system. These systems, with their smaller profile, can transmit greater power with smaller structures compared to classic V-belt pulley systems because the belts are manufactured as a single unit. They are preferred in applications where speed is more important than torque. Due to their full surface grip, they can perform the same task in an area 30% smaller in both diameter and width compared to V-belt pulleys. Therefore, both space and weight savings are achieved. Polyv belt pulley systems are used where belt slippage is a concern. They are frequently used in food, textiles, compressors and CNC machining industries.

Figure 3. Polyv Belt Pulley Systems [18]

3.4. Flat Belt Pulley Systems

In this system, the pulleys used do not have grooves; the part that wraps around the belt is machined in a flat or herringbone pattern. Additionally, small grooves are cut into the pulley to ensure the belt adheres perfectly to the pulley, especially on wide belts. This is done to create a vacuum effect with rotation, ensuring the belt adheres completely to the pulley surface. Power transmission is provided by a flat belt. Besides power transmission, flat pulleys are also used in various mechanisms. For example, they prefer in band saw machines to turn the belt, and in conveyor belts to move the belt. Another area where flat belt pulley systems are used is elevator systems. Elevator systems are systems that transfer granular materials to a high place. These systems, consisting of pockets arranged on a flat belt, require flat pulleys for belt drive.

Figure 4. Flat Belt Pulley Systems [19]

3.5. Rope Pulley Systems

The channel sections of the pulley are opened in a U shape to suit different rope standards. Since the channel sections are constantly exposed to friction, the pulley material should be able to resist wear. They are commonly used in elevators, transportation systems, and lifting crane systems.

Figure 5. Rope Pulley Systems [20]

3.6. Variable Belt Pulley Systems

Pulleys that operate with this system are called variable speed pulley systems. The biggest advantage of using this system is that the gear ratio is variable, not fixed. By moving the belt up and down, the side flanges of the pulley, which can move axially on a shaft, move closer together and further apart, thus providing partial control. The gear ratio changes depending on the diameter, which changes with the up and down movement of the belt. They are used in the automotive industry, textiles, and food machinery.

Figure 6. Adjustable Belt Pulley Set [21]

4. CONCLUSION AND RECOMMENDATIONS

Previous experience is crucial in belt pulley design and manufacturing for selecting pulleys and belts. The effects of operating conditions, such as driving shaft, initial overload, and pulley diameter, as well as environmental conditions, such as pollution, oiliness and humidity, must also be considered. These methods generally utilise different casting techniques, such as sand casting, metal casting and die casting. Many metals and alloys (Al, Fe, Mg, and their alloys) can be used to produce pulleys. The chemical and geometric structure of the cast pulley material, as well as its content, are the most important factors affecting its service life and efficiency.

CONFLICT OF INTEREST

The author(s) declare that they have no potential conflict of interest.

FINANCIAL DISCLOSURE

This research received no financial support.

DECLARATION OF ETHICAL STANDARDS

The authors of the article declare that the materials and methods used did not require ethics committee approval and/or regulatory approval.

REFERENCES

[1] Koç, E., (2007). Machine Elements Solved Problems, Nobel Publishing House, 2nd Edition, Adana, August 2007.
[2] Omurtag, M.H., (2010). Statics and Strength of Materials for Engineers, Nobel Publishing Distribution, 3rd Edition
[3] Omurtag, M.H., (2010). Mühendisler için Statik ve Mukavemet, Nobel Yayın Dağıtım, 3.Baskı.
[4] G.U.N.T. AT 200 Apparatus for Determination of Gear Efficiency, 2010
[5] Worley, W., (1955). Design of Adjustable Speed V-Belt Drives for Agricultural Machinery, SAE Technical pp:550-256
[6] Firbank, T.C., (1970). Mechanics of The Belt Drive, Int. J. Mech. Sci. Pergaman Pres 12: 1053-1063
[7] Gerbert, B.G., (1975). Pressure Distribution and Belt Deformation in V-Belt Drives, ASME Journal of Engineering for Industry 8:3-976
[8] Belofsky, H., (1976). On The Theory of Power Transmission By V-Belts, Oxford Management and Research Center, U.S.A. pp:263-275
[9] Gerbert, B.G., (1981). Some Notes on V-Belt Drives, ASME Journel of Engineering for Design 103(1): 8-18
[10] Dolan, J.P. and Worley, W.S., (1976). Closed Form Approximations to the Solution of V-Belt Force and Slip Equations, Journal Mechanism, Transmissions and Automation in Design 107(2):292-300
[11] Alciator, D.G. and Traver, A.E., (1989). Multipulley Belt Drive Mechanics Creep Theory and Shear, Proceedings of the International Power Transmission and Gearing Conference, Institute of Technology, Chicago, pp:65-70
[12] Rubin, M.B., (2000). An Exact Solution for Steady Motion of an Extensible Belt in Multipulley Belt Drive Systems, Faculty of Mechanical Engineering 122(3): 311-316
[13] Tanır, B., (2000). Theoretical and Experimental Analysis of Slippage in Belt Pulley Mechanisms, Master's Thesis, Balıkkesir University, Institute of Science, Department of Mechanical Engineering, pp:4-94.
[14] Uçar, M. and Cengiz, A., (2004). Experimental Investigation of the Effect of Working Environment Conditions on Slippage in V-Belts, Journal of Engineering Sciences 10(1):137-144.
[15] Kong, L. and Parker, R.G., (2005). Continuous Mechanics of Belt-Pulley Systems. Journal of Applied Mechanics 72(1):1-25.
https://gucaktarim.com/kayis-kasnak-sistem-cesitleri-ve-kullanim-yerleri/
[16] https://www.hamara.com.tr/urunler/v-kayis-kasnak-ve-burclari
[17] https://www.amazon.com.tr/Senkron-Tekerlek-Zamanlama-Al%C3%BCminyum-par%C3%A7alar%C4%B1/dp/B0D1ZFTVGN
[18] https://merkobelt.com.tr/product/poly-v-kayislar-ve-kasnaklar/
[19] https://www.zincirkizagi.info.tr/?p=1660
[20] https://www.erkcelik.com.tr/asansor/
[21] http://www.megamekanik.com/markalar/piazzalunga/es-rv-serisi-ayarli-kayis-kasnak-takimi.42.13.aspx