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Evaluation of Proximity Switch for Exhaust Fan Interlock System on Pellet Dryer at PT Chandra Asri Pacific Tbk

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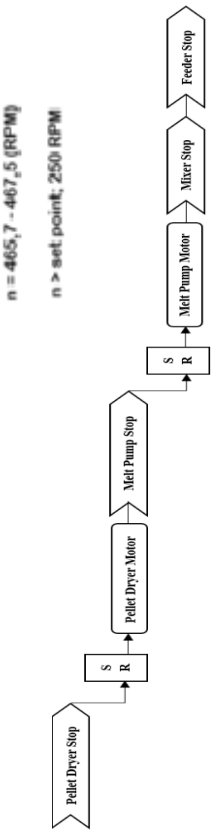
Graphical abstract



Abstract

Guaranteeing the proficient execution of pellet dryers within the petrochemical segment requests a reliable security and control framework. This inquire about investigates the utilize of an interlock framework utilizing nearness switches on the debilitate fan of a pellet dryer at PT Chandra Asri Pacific Tbk. Vicinity switches serve a crucial function in recognizing inconsistencies within the dryer's rotational speed, subsequently making a difference keep up operational parameters. The framework utilizes an inductive nearness switch to track the revolution of metallic components inside the dryer, transmitting parallel inputs to a recurrence converter. These inputs are changed into real-time information on rotational speed, which are fundamental for activating the interlock reaction in case of variations from the norm. The interlock setup, which is associated to key generation units such as the soften pump and blender, plays a preventive part against chain-reaction disappointments. The comes about appear a steady operational speed extending from 465.7 to 467.5 RPM—well over the least limit of 250 RPM—highlighting the system's unwavering quality. This setup minimizes startling shutdowns and diminishes hardware wear, in this manner boosting both security and operational efficiency.

Keywords: Proximity Switch, Interlock System, Pellet Dryer

Abstrak

Operasi industri petrokimia yang efektif dari pellet pengering memerlukan sistem kontrol dan keselamatan yang andal. Penelitian ini meneliti penerapan sistem interlock berbasis proximity switch pada kipas buang pengering pelet di PT Chandra Asri Pacific Tbk. Proximity switch memainkan peran penting dalam mendeteksi anomali pada kecepatan rotasi pengering, memastikan bahwa lini produksi beroperasi dalam parameter yang telah ditentukan. Proximity switch tipe induktif digunakan untuk memantau gerakan rotasi komponen logam dalam sistem pengering, dengan mengirimkan sinyal biner ke konverter frekuensi. Sinyal ini kemudian dikonversi menjadi data kecepatan rotasi secara waktu nyata, yang sangat penting untuk mengaktifkan mekanisme interlock saat terjadi penyimpangan. Sistem interlock yang terhubung dengan alat-alat produksi seperti melt pump dan mixer berperan penting dalam mencegah terjadinya kegagalan sistem secara beruntun. Temuan dari studi ini menunjukkan bahwa kecepatan rotasi tetap stabil antara 465,7 hingga 467,5 RPM, jauh di atas setpoint 250 RPM, yang menandakan pemantauan berjalan secara efektif. Guna pengintegrasian sistem yaitu meminimalkan pemicu kerusakan alat dan terhentinya operasi secara mendadak, sehingga mendukung efisiensi kerja dan keselamatan. Tulisan ini menyoroti betapa pentingnya penggunaan sistem berbasis sensor dalam aktivitas industri masa kini.

Kata kunci: Proximity Switch, Sistem Interlock, Pengering Pelet

1. INTRODUCTION

In large-scale petrochemical generation, guaranteeing persistent operation is crucial. PT Chandra Asri Pacific Tbk, the driving petrochemical firm in Indonesia, depends altogether on steady hardware and precise control mechanisms[1]. As generation needs extend, gear gets to be more complex, increasing the need for dependable blame location and anticipation frameworks. To address dangers like overheating or mechanical breakdowns, the company has received an interlock framework utilizing inductive proximity sensors[2]. These frameworks convey real-time checking of apparatus conditions, making a difference to deflect genuine harm and keep up compliance with security guidelines. [3].

1.1 *Plant*s MTBE & B1 *Plant*

Chandra Asri Pacific oversees Indonesia's spearheading MTBE (Methyl Tert-butyl Ether) and B1 (Butene-1) generation offices, with yearly yields of 128,000 tons and 43,000 tons, individually. Authorized by Lummus Innovation, these plants are aiming to fulfill nearby request for octane enhancers, already met primarily through imports. Arranged inside Chandra Asri's coordinates petrochemical location in Ciwandan, both offices started working in 2020. Their foundation is pointed at decreasing dependence on imported materials whereas progressing the household petrochemical division.

Figure 1. Show capacity MTBE *Plant* [1]

1.2 *Proximity Switch*

Figure 2.Sensor Proximity Switch [2]

A vicinity switch may be a sort of sensor outlined to distinguish adjacent objects without direct contact [3]. These switches are divided into two main categories: inductive and capacitive. The distinction lies in the materials they detect—inductive switches target metal objects through electromagnetic waves that produce eddy currents, while capacitive switches are capable of sensing non-metallic materials by detecting changes in the electric field. The sensors operate using high-frequency oscillators that create electromagnetic fields. The presence of metallic or dielectric materials alters the oscillation amplitude around the sensor, allowing for accurate detection [2].

1.3 *Elektromagnetic*

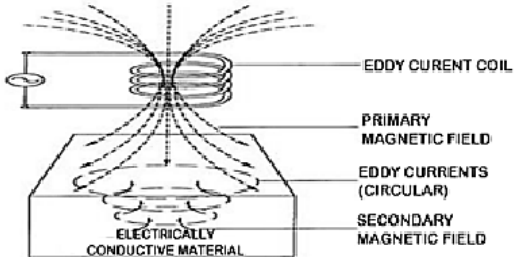


Figure 3. Testing Eddy Current

Electromagnetic waves consist of electric and magnetic field components that propagate perpendicularly to the amplitude of each wave. When electromagnetic waves encounter a metallic material, they significantly induce the material, causing a reduction in electrical wave energy due to the

induction process occurring within the material. A similar interaction happens with magnetic materials, where the magnetic component dominates over the electric component. When electric current flows through a conductor, it produces a circular magnetic field with lines forming loops around the conductor[4]. The direction of the magnetic field's rotation is determined by the direction of the current, generating a perpendicular field that becomes stronger closer to the center of the conductor. This is due to the longer path of the magnetic loop further from the conductor, which weakens the magnetic flux. Induction occurs when moving magnetic flux intersects the magnetic lines surrounding a conductor, causing free electrons in the conductor to move, thereby generating current. This induced current results from the mechanical action of a generator placed in a moving magnetic field, converting mechanical energy into electrical energy as the current flows through the conductor. Without motion, no current is generated. This motion is necessary for magnetic field lines to intersect the conductor transversely, which can be achieved either by movement of the magnetic field or the conductor itself [5].

1.4 Amplitudo, Frekuensi, dan Periode

A wave is a vibration capable of propagating through a medium. However, not all waves have the same magnitude. This magnitude is influenced by various factors and is referred to as the amplitude. The greater the wave, the larger its amplitude becomes [6]. The period (denoted as T) refers to the time required for an object to complete one full oscillation or vibration [7]. Hence, the period represents the time needed to generate a single wave cycle. The period can be used to calculate the frequency of a wave.

$$T = \frac{t}{n} \tag{1.1}$$

Frequency is the inverse of the period. It indicates the number of wave cycles generated in a unit of time, typically per second. The longer the period, the lower the resulting frequency, and vice versa. This illustrates an inverse relationship between the two concepts [8]. In other words, as frequency increases, the period decreases. The formula used to calculate frequency is:

$$f = \frac{n}{t} \tag{1.2}$$

1.5 *Frequency Converter*

Figure 4. Frequency Converter

The recurrence converter may be a gadget utilized to perused and prepare frequency input from the associated sensor. Within the pellet dryer framework, the sensor utilized may be a vicinity switch, which converts recurrence signals into voltage or current. This gadget works inside a recurrence run of up to 40 kHz. Moreover, it gives analog yield within the extend of 0–10_V DC or 0–20 mA.

A key include of the KFU8-FSSP-1.D is its tall accuracy transmission capability, with an precision of less than 0.2% of the full-scale esteem. Besides, it is prepared with progressed operational pointers, counting a keypad-driven menu for parameter setup and a 4-digit 7-segment Driven show that appears real-time recurrence or rotational speed values.

The gadget capacities by utilizing flag pieces gotten from the sensor. When the sensor recognizes the nearness of an protest, it produces a esteem of 1; something else, it produces a esteem of 0. Based on the recurrence of dynamic discovery, the gadget consequently changes over the recurrence input into rotational speed measured in RPM (Insurgencies Per Diminutive) [9].

1.5 Pellet Dryer

Figure 5. ***Pellet dryer***

At Chandra Asri Pacific, the pellet drying handle utilizes a centrifugal dryer. This sort of dryer is built to tackle centrifugal drive and gravity for its operation [10]. By turning plastic pellets at tall speeds, it successfully ousts and evacuates remaining water from their surfaces.

This method of drying is both efficient and independent of solar heat, enhancing its effectiveness and energy-saving qualities. An additional step, referred to as "blow-up," is integrated into the dryer to eliminate any residual moisture after the main drying stage. This ensures that the final plastic pellets are completely clean and moisture-free.

2. METHODS

The research initiates with a conceptual review of the polypropylene plant to grasp the full system's structure and functionality.

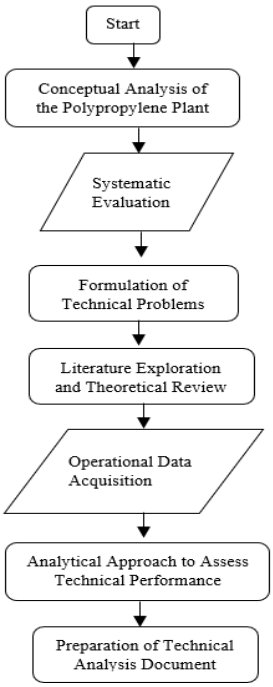


Figure 6. Reasearch Flow Diagram

This is succeeded by a structured assessment to pinpoint specific aspects that need more detailed exploration. Upon identifying critical challenges, technical problem statements are formulated as the basis for subsequent analysis.

Table 1. Specification Proximity Switch [11]

Type	*BI5-M18-AD46X*
ID	*4411022*
General Data	
Rated switching distance	*5 mm*
Mounting conditions	*Flush*
Secured operating distance	$\leq (0{,}81 \times sn) mm$
Correction factors	*St37 = 1; Al = 0.3; stainless steel = 0.7; Ms = 0.4*
Repeat accuracy	$\leq 2\%\ of\ full\ scale$
Hysteresis	*1…15%*
Electrical Data	
Operating voltage	*10…65 VDC*
Residual ripple	$\leq 10\%\ U_{ss}$
DC rated operational current	$\leq 100\ mA$
Residual current	$\leq 0.6\ mA$
Isolation test voltage	$\leq 0.5\ kV$
Short-circuit protection	*yes / Cicil*
Voltage drop at Ie	$\leq 5\ V$
Wire breakage/Reverse polarity protection	*Complete*
Output function	*NO contact, 2-wire*
Smallest operating current	$\geq 3\ mA$
Switching frequency	*0.5 kHz*
Mechanical data	
Design	*Threaded barrel,* $M18 \times 1$
Dimensions	*54 mm*
Housing material	*Metal, CuZn, Chrome-plated*
Active area material	*Plastic, PA12-GF30*
End cap	*Plastic, EPTR*
Max. tightening torque of housing nut	*25 Nm*
Electrical connection	*Cable*
Cable quality	$\emptyset 5.2\ mm, LifYY, PVC, 2\ m$
Core cross-section	$3 \times 0.34\ mm^2$
Environmental conditions	
Ambient temperature	$-25 \ldots +70°C$
Vibration resistance	*55 Hz (1mm)*
Shock resistance	*30 g (11 ms)*
Protection class	*IP67*
MTTF	*2283 years acc. to SN 29500 (Ed. 99) 40 °C*
Switching state	*LED, Yellow*

Table 2. Specification Converter[12]

Supply	
Rated Voltage	*V_{dc} = 200 – 230 V, V_{ac} = 100 – 130 V*
Fusing	*External Fusing 4 A*
Power ConsumPTion	*Dc = < 5 W, Ac = < 5 Va*

Indicators/Operating Means	
Type	*4-Digit, 7-Segment Red Display, 7 Mm Digit Height*
Display Interval	*0.002 ... 9999 Hz Or 0.01 ... 9999 Min-1*
Parameter Assignment	*Keypad-Driven Menu*
Input 1	
Connection	*Terminals 8-, 9+*
Connectable Sensor Types	*NAMUR Sensor According To DIN EN 60947-5-6*
Open Loop Voltage	*8.2 V DC*
Short-Circuit Current	*6.5 mA*
Switching Point	*1.2 ... 2.1 Ma Switching Hysteresis Approx. 0.2 mA*
Impedance	*1.2 kOhm*
Input 2	
Switching Point	*High: 16 ... 30 V DC; Max.10 Ma; Ri ≅ 3 Kohm Low: 0 ... 6 V DC*
Connection	*Terminals 7+, 13- Sensor Supply Terminals 14, 15 NPN/PNP Input (Galvanically Isolated)*
Connectable Sensor Types	*2-, 3-, Or 4-Wire Proximity Switches And Incremental Rotary Encoder*
Sensor Supply	*19 ... 28 V DC Non-Stabilised; ≤ 30 Ma Short-Circuit Protected*
Output	
Analog Voltage Output	*0 ... 10 V DC; 2 ... 10 V DC; 30 Ma Max.; Resolution: 12 Mv; Ri ≥ 330 Ω (Terminal 5+, 6-)*
Analog Current Output	*0 ... 20 Ma; 4 ... 20 Ma; Resolution: 25 µa; Ri ≤ 600 Ω (Terminal 4-, 5+)*
Digital Incrementing	*≥ (Ub -3 V), 20 Ma, Short-Circuit Proof (Terminals 1-, 2+) With Frequency Division Fin /1 ... Fin /9999*
Transfer Characteristics	
Input Frequency	*≤ 40000 Hz, Pulse Pause/Pulse Length: ≥ 12 µs*
Deviation	*≤ 0.2 % Of Full-Scale Value*
Changing Interval	*5 Ms (Internal Processing Time)*
Standard Conformity	
Electromagnetic Compatibility	*Acc. To EN 50081-2 / EN 50082-2*
Ambient Conditions	
Ambient Temperature	*-25 ... 40 °C (-13 ... 104 °F)*
Storage Temperature	*-40 ... 85 °C (-40 ... 185 °F)*
Relative Humidity	*Max. 80 %, Not Condensing*
Altitude	*0 ... 2000 M*
Operating Conditions	*The Device Has Only To Be Used In An Indoor Area.*
Mechanical Specifications	
Connection Assembly	*Warning: Make sure the equipment is linked solely to a power supply that can be turned off. The corresponding switch or circuit breaker should be clearly labeled and readily accessible to serve as the main power disconnection point.*
Degree Of Protection	*IP20*
Connection	*Coded, Removable Terminals , Max. Core Cross Section 0.34 ... 2.5 Mm2*
Construction Type	*Modular Terminal Housing In Makrolon, System KF For Use In The Switch Cabinet/Switch Cabinet Module*
Mounting	*Snap-On To 35 Mm Standard Rail Or Screw Fixing*

A converter functions to transform the signal frequency from the proximity switch into a rotational speed measurement, expressed in revolutions per minute (RPM).

3. RESULTS AND DISCUSSION

3.1 Result

Plastic pellets manufactured by PT Chandra Asri Pacific Tbk are dried using a high-speed drying machine, which efficiently eliminates remaining surface moisture. This drying activity also generates data on the operational rotation speed of the dryer.

Table 3. Measurement Data of Rotational Speed on the Pellet Dryer

Capacity (Ton)	Motor Speed (RPM)
22-24	466,2
	467,1
	465,7
	466,9
	467,5
	466,4
	467,3
	467,0
	466,9

3.2 Interlock

At PT Chandra Asri Pacific Tbk, an interlock system is employed to safeguard production machinery from potential operational damage. The system checks the readiness of equipment prior to activation and automatically halts its operation if any irregularities are detected.

In the event of a disturbance, the system identifies the fault location and sends a warning signal to halt the corresponding equipment. Once inspection is completed and the equipment is deemed safe, the process can resume. However, if the disturbance persists, the system will isolate the affected equipment to prevent further damage. This process is illustrated in the image below.

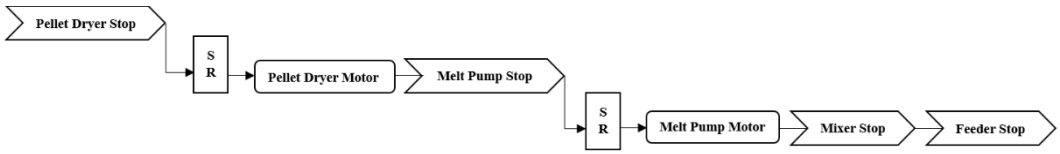


Figure 6. Flowchart Interlock

In this observation, the analyzed equipment is the pellet dryer, which operates when it receives pellets that have hardened from the water-cooling process. The drying process involves several stages, and a malfunction in the pellet dryer can trigger a trip in the entire production line.

When the main motor of the pellet dryer stops, the system sends a signal to stop the melt pump, which is responsible for pumping the polymer from the mixer to the screen changer. If the melt pump stops, its drive motor also stops, causing both the mixer and feeder to halt as well. This disturbance is commonly caused by the pellet dryer's rotational speed not matching the setpoint, thus activating the interlock system to prevent further damage.

3.3 Pellet Dryer

Figure 7. Tank Pellet Dryer

The pellet dryer at PT Chandra Asri Pacific Tbk is used to dry the output from the production process. It operates by spinning polypropylene pellets until they are fully dry. The working principle relies on rotation that drives the pellets outward from the shaft due to centrifugal force.

This force is utilized to remove water remaining from the hardening process using cooling water after the pellets have undergone melting and cutting. The water separated from the pellets is then directed into a cooling water tank for reuse in the next production cycle. Moisture left on the pellets could lead to undesired effects during packaging.Dry pellets are forwarded to a pellet screener, which detects and separates pellets that do not meet size standards, such as clumps or undersized pellets. Perfectly dried and appropriately sized pellets proceed to the bagging process for packaging.

By using this machine, efficiency is improved in terms of both time and space, compared to traditional drying methods. Sun drying, for example, requires a long time and a large area to ensure full exposure to sunlight. Moreover, as it relies on natural resources, weather and temperature are unpredictable, which can affect production.This is why the pellet dryer is crucial. If it trips, it can delay production and affect other interconnected equipment.

3.4 Proximity Switch

Figure 8. Sensor Proximity Switch

The proximity switch sensor is used at PT Chandra Asri Pacific Tbk, especially in equipment such as the pellet dryer. In the polypropylene plant, the proximity switch used is of the inductive type, which can only detect metallic materials.

When the proximity switch detects metal, eddy currents are induced. These currents inform the sensor of the presence of metal, as the oscillator output signal will show reduced amplitude compared to when no metal is present. According to the sensor's specifications, it can detect objects up to 5 mm away. Therefore, the proximity sensor is installed at a distance of less than 5 mm from the rotating object in the pellet dryer.

The proximity switch measures how frequently metal is detected, which is used to determine the rotational speed of the pellet dryer. This speed can then be monitored in real-time. Based on the data in Table 4.1, the rotational speed of the pellet dryer fluctuates but remains within the range of 465.7 RPM to 467.5 RPM. This is considered stable, as the setpoint of the equipment is around 250 RPM.

3.5 Converter

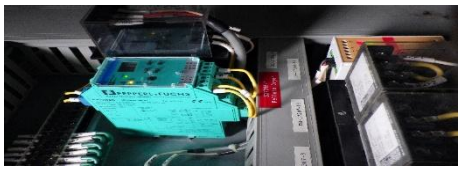


Figure 9. Frequency Converter

The frequency converter at PT Chandra Asri Pacific Tbk is used to convert the frequency obtained from a sensor into rotational speed, which serves as an indicator of whether the equipment is operating properly.This device converts the frequency signal received from the proximity switch sensor into rotational speed measured in RPM. When the proximity switch detects a moving object, the detected electromagnetic wave is converted into a digital signal block, which is then processed to calculate rotational speed.

The vicinity switch creates a computerized flag, creating a esteem of 1 when an question is recognized and when none is display. These parallel signals, followed over time, are analyzed to decide the rotational speed of the pellet dryer. By tallying the number of '1' signals inside a particular time frame—commonly per minute—the framework infers the rotational recurrence, which is hence changed over to RPM for execution observing purposes.

4. CONCLUSION

At PT Chandra Asri Pacific Tbk, the interlock framework built around nearness switches plays a crucial part in keeping up secure dryer operations. Through ceaseless checking and the programmed enactment of security measures in reaction to inconsistencies, the framework decreases the probability of operational risks. The combined utilize of vicinity sensors and recurrence converters boosts computerization levels and altogether makes strides the unwavering quality of the generation prepare.

The nearness switch joined to the pellet dryer at PT Chandra Asri Pacific Tbk serves as a instrument for checking its revolution speed. Whereas the target speed is set at 250 RPM, real readings show values of 465.7 and 467.3 RPM. Within the occasion of an over-burden or mechanical hindrance, the interlock framework mediates consequently to halt the operation and ensure the hardware from potential hurt.

REFERENCES

[1] Chandra Asri Petrochemical, “Laporan tahunan PT Chandra Asri Petrochemical 2021, Strategic Partnership For A Better Future (Kemitraan Strategis Untuk Masa Depan Lebih Baik),” p. 449, 2021, [Online]. Available: https://www.chandra-asri.com/files/attachments/reports/annual/Annual Report Chandra Asri 2021.pdf

[2] D. Aribowo, D. Desmira, R. Ekawati, and N. Rahmah, “Sistem Perancangan Conveyor Menggunakan Sensor Proximity Pr18-8Dn Pada Wood Sanding Machine,” *EDSUAINTEK J. Pendidikan, Sains dan Teknol.*, vol. 8, no. 1, pp. 67–81, 2021, doi: 10.47668/edusaintek.v8i1.146.

[3] M. F. Z. Fuad, A. Arifin, and M. Nuh, “Perbaikan Sistem Kendali Robot Tangan EH1 Milano Menggunakan Sistem Kendali Loop Tertutup,” *J. Tek. ITS*, vol. 4, no. 1, pp. A59--A64, 2015, [Online]. Available: http://ejurnal.its.ac.id/index.php/teknik/article/view/8476

[4] A. Naafiah, “Karakteristik Pemantulan dan Pembiasan Gelombang Elektromagnetik Terpolarisasi-s Pada Bidang Batas Kiri Bahan Antiferomagnetik FeF2 Dalam Konfigurasi Faraday,” *J. Fis. Indones.*, vol. 23, no. 3, p. 7, 2020, doi: 10.22146/jfi.v23i3.51781.

[5] A. S. T. Prayuda and W. H. A. Putra, "Analisis Kemampuan Pendeteksian Pengujian Eddy Current terhadap Crack Toe pada Sambungan Tee Material Aluminium 5083 yang Dilapisi Non-Conductive Coating dengan Variasi Kedalaman dan Panjang Crack," *J. Tek. ITS*, vol. 10, no. 1, 2021, doi: 10.12962/j23373539.v10i1.59780.

[6] H. Rismawan *et al.*, "MENENTUKAN NILAI PERIODE, AMPLITUDO, FREKUENSI DAN MEMVISUALISASI GETARAN HARMONIK PADA PEGAS DALAM BENTUK GELOMBANG," *J. Fis. dan Apl.*, vol. 8, no. 1, pp. 25–29, 2023, [Online]. Available: https://doi.org/10.35508/fisa.v8i1.11820

[7] N. Farida, P. Melati, R. Ruqoyah, V. P. Yuristiansyah, and G. Antarnusa, "Pengaruh Amplitudo (A) , Frekuensi (f), dan Tegangan Gelombang Pada Tali Berbasis PheT Simulation," *Semin. Nas. Pendidik. Fis.*, vol. 3, no. 1, pp. 408–414, 2020.

[8] S. Sutisna, "*Getaran dan Bunyi*," Modul 1, pp. 48–54, 2017.

[9] G. Simamora and A. Gultom, "Analisa pengaruh frekuensi terhadap arus dan rpm pada pompa motor listrik yang menggunakan inverter sebagai variable speed drive di Gedung Park 5 Cilandak - Jakarta Selatan," *J. Cahaya Mandalika*, pp. 2278–2292, 2024.

[10] O. A. Khoryanton, P. Yanuar, B. F. Nugraheni, and T. A. Kristiawan, "Analisis kinerja centrifugal dryer guna mengurangi cycle time dan tingkat kebisingan pada proses blow up," vol. 19, no. 2, pp. 223–230, 2023.

[11] I. D. Bi and C. No, "BI5-M18-AD46X Inductive Sensor," Datasheet, pp. 5–7.

[12] P. Rail, "Frequency voltage current converter." *Pepperl+Fuchs,* [Online]. Available: https://www.pepperl-fuchs.com/global/en/classid_247.htm?view=productdetails&prodid=24681