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Automation of Mill Lubrication Oil System Control Using PLC

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Abstract

This journal deals with problems occuring in the mills.RCC bunker has some problems for the free flow of lignite**.** The most frustrating problem is the bunker choke. A bunker choke is caused when the lignite gets accumulated on the inside surface of bunkers. A properly designed and maintained system should not include this problem. Due to the rough surface inside the bunker and the moisture present in lignite, the lignite gets choked on the surface of bunker. Thus the free flow of lignite cannot be achieved. Especially during the rainy season, the lignite gets choked easily inside the bunker. Air blasting system is operated manually whenever the choke is found. Manual operation may not clear all the chokes inside the bunker. So PLC programming is implemented. The lubrication system is destined for continuous supply of oil into the mill double bearing and main motor bearings to lubricate and cool them. The lubrication system consists of individual oil station of low pressure with oil coolers connection oil pipe-lines with fittings. When the oil decreases to the lowest level of oil take, there generates the inhibition for mill start-up or (when the mill is operating) warning signal about the necessity of filling in the oil tank and protection for switching off with time delay of 90 min. A required oil level is kept separately for each bearing. In this case the oil level inspection is visualized and automated

Keywords: Mill, RCC Bunker, PLC.

I. Introduction

Control engineering has advanced over time. In the past humans were the main methods for controlling a system. PLCs have been gaining popularity on the factory floor and will probably remain predominant for some period to arise.

Ladder logic is the main programming method used for PLCs. When a voltage is applied to the input coil, the resulting current generates a magnetic field. The magnetic

field tweaks a metal switch (or reed) towards it and the contacts touch, terminating the switch. The contact that ends when the coil is energized is called normally open. The normally closed contacts trace when the input coil is not energized. Relays are normally drawn in diagrammatic form using a circle to represent the input coil. The output contacts are presented with two parallel lines. Normally open contacts are exposed as two lines, and will be open. When the input is not energized.
More complex systems should not control with combinatorial logic alone. In these cases we can use events to estimate the condition of the system. Typical events used by a PLC include; first scan of the PLC - indicating the PLC has just been turned on time since an input turned on/off - a delay count of events - to wait until set number of events have occurred latch on or unlatch - to lock something on or turn it off.

II. LIGNITE HANDLING SYSTEM

PLC based Lignite Handling & Storage System consisting of conveyors, screens, crushers & auxiliaries grouped as External System and Internal System. The conveyor system can be started from Local, PLC and Auto modes as and when required. The above conveyor system is capable of conveying 2000 T of lignite/hour. The RCC bunker capacity is 10,000 T and each unit has 6 bunkers of each capacity 450 T. The External conveyor System is used to receive Lignite from Mine I through G7/R5 conveyor and storing it at RCC bunker. The Internal conveyor System is used to transfer the Lignite from RCC Bunker to Boiler Bunker through various conveyors via, screen and crusher. Paddle feeders reclaim lignite from over ground storage bunkers. Two numbers of paddle feeders have been provided on each side of the slotted bunkers. Paddle feeders PF1A and PF2A feed to conveyor 12A and Paddle feeders PF1B and PF2B are feeding to conveyor 12B. Each paddle feeder is rated for 2000 tons/hour. One paddle feeder will be operating at a time and other paddle feeder will be in standby. Two numbers of over band magnetic separators MS2A and MS2B are installed on conveyor 12A and 12B. In the crusher house, two numbers of reversible conveyors RC1A and RC1B have been provided. RC1A receives lignite from conveyor 12A which in turn discharges lignite on to reversible feeder conveyor RFC1A (when RC1A run in forward direction) or RFC1B (when RC1A run in reverse direction) for feeding to either Screen A/ Screen B or directly on unidirectional shuttle conveyors USC2A. Similarly RC1B receives lignite from conveyor 12B which in turn discharges lignite on to reversible feeder conveyor RFC1A or RFC1B for feeding to either Screen-A / Screen-B or directly on unidirectional shuttle conveyors USC2B. The under size lignite (of less than 80mm) from the screen SR1A and the crushed lignite from CR1A is fed to Unidirectional shuttle conveyor USC2A whereas the under size from screen SR1B and crushed lignite from CR1B is fed to unidirectional shuttle conveyor USC 2B. The USC2A and USC2B feed the crushed/screened lignite either to conveyor 13A or 13B. Two numbers of Weighing scales BS2A and BS2B installed on conveyor 13A and 13B measure rate and the quantity of lignite supplied to boiler

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bunkers. Two number over band magnetic separators MS3A and MS3B are installed on conveyor 13A and 13B.

A bypass to crusher and screen has been provided in each circuit. In this case it is possible to feed conveyor USC2A and USC2B directly from reversible feeder conveyor RFC1A and RFC1B respectively bypassing Screen and Crusher.

A cross feeding arrangement is provided in JT1-Junction tower. In this case it is possible to feed

1. Conveyor 14A and 14B directly from BC13A and BC13B.
2. BC13A to BC14B through shuttle conveyor SC1B.
3. BC13B to BC14A through shuttle conveyor SC1A.

The lignite is supplied to boiler bunker through conveyors 14A and 14B. Conveyor 14A feeds lignite to reversible shuttle conveyor RSC3A to feed all twelve boiler bunkers of unit1 (G1 to G6) and unit2 (G7 to G12). Similarly BC14B feeds RSC3B to feed all twelve boiler bunkers.

The lignite level sensor installed in each boiler bunker with 0 to 8.2 meters range, which indicates each boiler bunker level in DCS and in SCADA operator station in LHS control room.

III. THE LUBRICATION SYSTEM

The lubrication system is destined for continuous supply of oil into the mill double bearing and main motor bearings to lubricate and cool them. The lubrication system consists of individual oil station of low pressure with oil coolers connection oil pipe-lines with fittings. More than nominal pressures, the warning signal is switched on, informing about the necessity of shifting to reserve filter and replacement of filter-element in operating filter.

If the oil temperature in oil tank is less than 20 °C, the oil heater is switched on immediately. The oil heater automatically switches off when the oil temperature in oil tank rises up to +25 0C or more. When the oil temperature after cooling rises up to +45 °C the electric contact thermometer CTO13 gives the pulse for signaling the necessity of switching on cooling water supply. When the oil decreases to the lowest level of oil take, there generates the inhibition for mill start-up or (when the mill is operating) warning signal about the necessity of filling in the oil tank and protection for switching off with time delay of 90 min. A required oil level is kept separately for each bearing. In this occasion the oil level inspection is visual and automated. The automatic inspection of the oil level in each bearing case is performed by two level-switch transducers located in the corresponding volumes of the housing. The visual inspection is performed by means of oil indicators installed on the double isms body wall. If the oil level decreases the required level then there is a immediate trip signal to mill**.**

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a. System Operation

Operation of Auto route matrix:

- Select the selector switch on the control desk in Auto route matrix.
- Press the Interrupt Pushbutton on the control desk. This resets the previous selected path memory.
- Press the Program ON illuminated push button on the control desk and the illuminated Program ON lamp will be lit as a feedback to select the path.
- Select the desired path by pressing the route matrix push buttons along the path of transport by the appropriate push button provided on the matrix panel in the control room. Any correction in the middle can always be done by interrupting using the Interrupt Pushbutton and reassigning the path in the correct way.
- After selecting the path, the SET push button has to be pressed. Thus the path selected is described to the system.
- After Set pushbutton is pressed, path test is carried out in the PLC logic for validation of the selected path. If the selected path is not valid, an alarm will appear and the matrix should interrupt and new valid path should reselect as mentioned above.
- All the drives in the selected path should be in remote selected in the MCC panel.
- There should not be any trip signal for the drives in the selected path in the Motor status screen in the operator station.
- Ensure the release of emergency push buttons on the control desk for the selected drives in the path.
- Inform in the public address system about the system start Internal/External.
- Now press the system START push button on the control desk. The field hooter will be energized for particular time and the illuminated push button system START blinking up to the field hooter ON time and the same will become steady after the hooter time off and system starts the equipment in the selected path will start one by one from the destination to the feeding end.

b. Boiler Bunkers

There are 6-bunkers in unit-1 and, 6 bunkers in unit-2. The boiler bunkers should be filled regularly by starting the conveyors sequentially from boiler bunker to the source external storage bunker. Each mill bunker height is 10 meters which can hold 540 tons of lignite and installed with level transmitter having 0 to 8.2 meters range. Bunkers should maintain minimum level of 3 meters.

The system is having redundant conveyors, with A-stream and B-stream and hence with different combinations 64 ways of transporting lignite from storage bunker situated one kilometer away from boiler bunkers is possible as shown in the lignite handling system scheme.

The automation of Lignite handling system consists of two stages

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- Starting the conveyors from boiler bunker to the storage bunker by sequential control using PLC.
- Filling the boiler bunkers automatically one by one using PLC.

C. Air cannon system

Air cannon system is used to remove the choke inside the bunker. Generally during rainy seasons due to the moisture present in the lignite, the lignite gets sticked to the bunker surface. This leads to the formation of choke on the walls of the bunker. This choke is usually removed by air cannons or air blasting systems and manually. These air cannons are fixed on the outer walls of the bunker. Air cannons are controlled by electrically operated valves with pressure sensors with refill/operating system, remote monitoring and integrated with plant automation. Air cannons are positioned at 2 elevations, control system is provided in such a way that air blasts follow one another at preset intervals or simultaneously for air cannons installed in groups. Control is capable of providing manual as well as sequential timer control. In case of sequential timer control, both cycle time and impulse time are programmable. Simultaneous activation of two air cannons is carried out to reduce possibility of long term eccentric loading due to one air cannon operation. The operating air pressure is 4-6 kg/cm^2

D. Air Blasting system

Air blasting is done manually by pressing the pushbutton provided on the system. This action makes a small opening by the movement of diaphragm. The net volume of air present inside the cylinder is hence forced inside the small gap with large velocity. This high velocity air forces the choke to crack and blasts it. The schematic diagram for this blast is shown below in fig 2.

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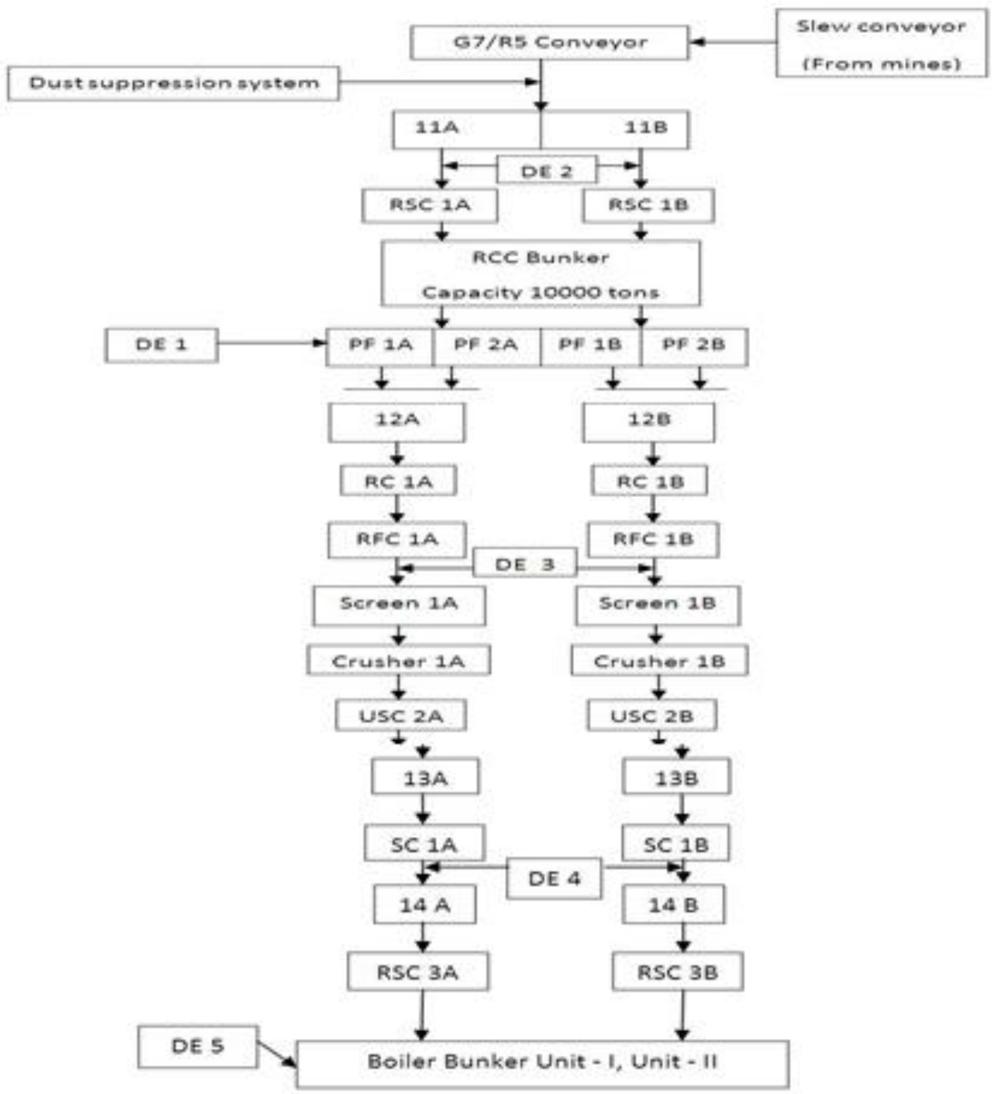

Fig 1 : Boiler Bunker Unit

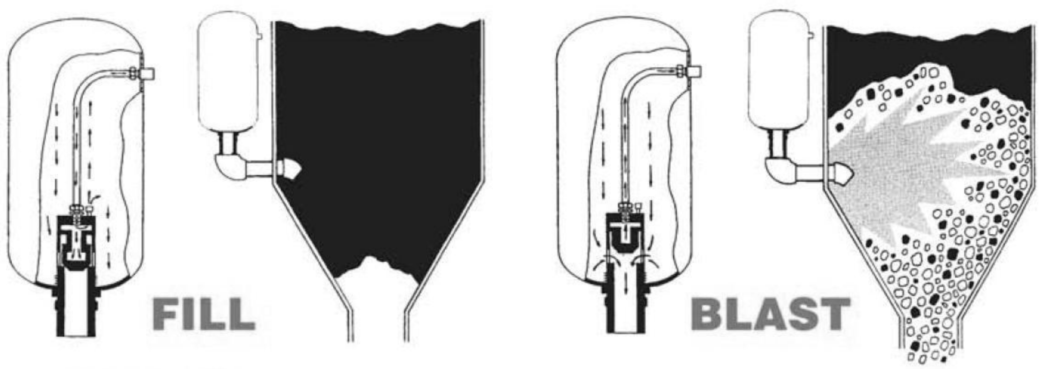

Fig 2: Air blasting system

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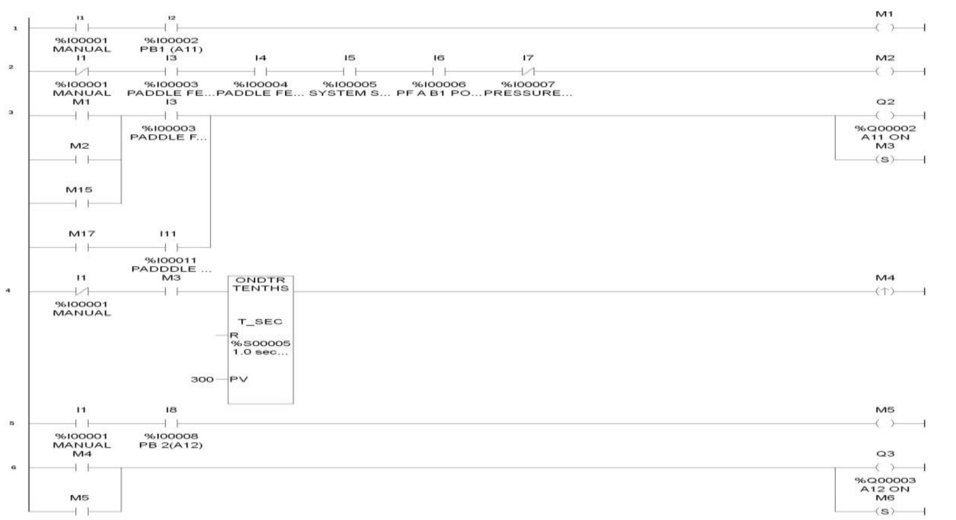
E. System Architecture

The PLC based control system is designed based on Allen Bradley state-of-the-art and latest PLC-5 Control Net processor (1785-L80c15). The Control Net network is a high speed, deterministic network used between PLC to I/O devices. There are two redundant main PLC-5 Control Net processors housed in a separate I/O rack with power supply and both of them are connected through a Control Net network. Each unit is considered as node in a Control Net network. The required number of I/O modules is housed in an I/O rack and it is connected to the control net bus. Each I/O rack is considered as a node and main processor collects the I/O data through control net bus from I/O processor (1771-ACNR). The above PLCs and I/O racks are enclosed in different panels located in the control room. Ladder logic is the main programming method used for PLCs. As mentioned before, ladder logic has been developed to mimic relay logic. The decision to use the relay logic diagrams was a strategic one. By selecting ladder logic as the main programming method, the amount of retraining needed for engineers and tradespeople was greatly reduced. Modern control systems still include relays, but these are rarely used for logic. A relay is a simple device that uses a magnetic field to control a switch. When a voltage is applied to the input coil, the resulting current creates a magnetic field. The magnetic field pulls a metal switch (or reed) towards it and the contacts touch, closing the switch. The contact that closes when the coil is energized is called normally open. The normally closed contacts touch when the input coil is not energized. Relays are normally drawn in schematic form using a circle to represent the input coil. The output contacts are shown with two parallel lines. Normally open contacts are shown as two lines, and will be open (non-conducting) when the input is not energized. Normally closed contacts are shown with two lines with a diagonal line through them. When the input coil is not energized the normally closed contacts will be closed (conducting).

IV.RESULS AND DISCUSSIONS



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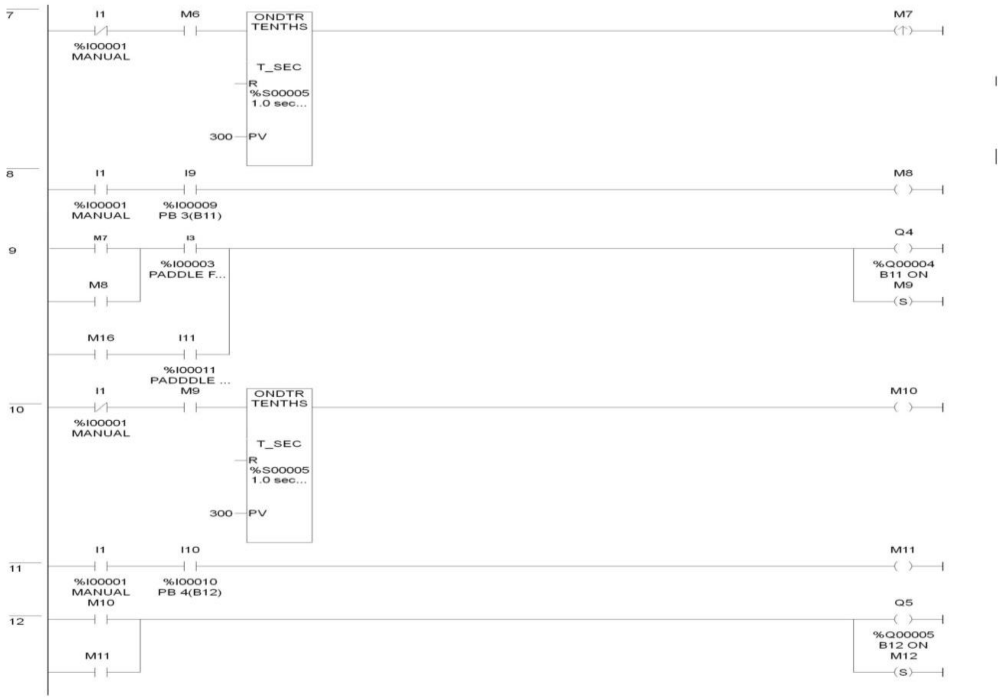

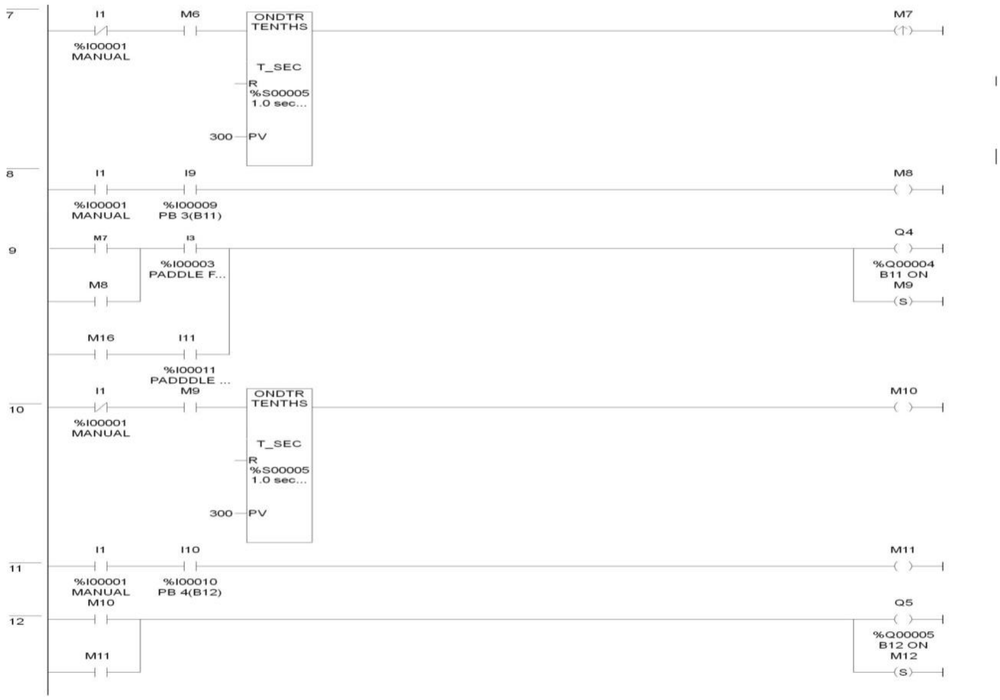

Fig 3: Ladeer logic for lubrication system

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V.CONCLUSION

We can only determine that there is choke inside the bunker by means of measuring the flow rate of lignite. We can't determine the location of choke inside the bunker. Thus we need to spend large time to clear the choke by actuating all the air cannons to blast the air. Thus the position of choke area can't be found just by calculating the lignite flow rate. By actuating all the air cannons, there will be unwanted vacuum created inside the bunker which also leads to the decrease in the flow of lignite. If removal of choke is not effectively achieved with air cannon, it has to be done manually, which is a dangerous job. It may lead to fall of lignite over workers and cause serious health hazards which may even lead to death. Thus if choke is not properly removed and gets over deposited, it can't be removed by air blasting. So, it has to be removed manually which is a difficult work. The above listed problems lead to various consequences subsequently. Occurrence of frequent bunker chokes and attending huge volume of these works by the workmen results in fatigue to them and efficiency of the workmen is coming down. Since the flow of lignite rate reduces, the input reduces and hence the power production decreases and hence there is reduction of boiler load. The power production is reduced due to the reduction in the rate of lignite flow. Since the power production decreases, there is reduction in the revenue due to the absence of continuous flow of lignite. Though the lignite flow rate is low, we have to supply the required demand. Thus there has to be a supply of extra oil to meet the demand and achieve required production level. The amount for the oil is high and hence the unit rate increases. Air blasting can be done automatically at a specific interval of time using PLC programming. Another option is by checking the load current of paddle feeder. If the paddle feeder consumes low load current, the specific area has less lignite feed rate. Therefore, the specific area has choke. Hence the corresponding air cannon can be actuated if the paddle feeder consumes low load current using PLC programming.

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