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Improvement of Eirich Mixer in Manufacturing Process of Graphite Electrode with Multiple Cooling Points

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***Abstract*: In manufacturing, mixing is an operation that changes the heterogeneous mixture to homogeneous mixture. There are certain machineries that are used to mix the raw materials together to get a proper mixture of the product which are known as the intensive mixers, but at times the mixture of the materials is not properly mixed which create the problem of formation of lumps, increased batch weight of the mixture, irregular mixing due to tool wear that will lead to decrease in tool life, increase in power consumption of the mixer etc. which cannot be overlooked. In this review the research is done in the eirich mixer to solve the problems through the changes in the basic design and the structure of the mixing machine by adding multiple cooling points which can enhance the productivity and profit of the organisation. The cooling time and the variable torque figures are also discussed.**

***Keywords*: Eirich mixer, Cooling points, Multiple Cooling Points.**

I. INTRODUCTION

In industries, mixing is a unit operation that involves the manipulation of a heterogeneous physical system with the intent to make it more homogeneous. The intensive mixers were developed for the most diverse jobs in the processing of the raw materials, mechanical mixtures and compounds. Variable setting of machine components and the energy range ensures a high degree of efficiency. Three components determine the characteristics of these mixers:

1. A rotating mixing pan
2. A rotating mixing tool
3. An adjustable multi-purpose wall-bottom scraper

There are different mixers for mixing as some mixers are used to operate under atmospheric pressure whereas others work under vacuum and/ or for combining complex preparation processes. Processing steps can be performed either singly or in combinations in one machine. They include: Mixing, reacting, dispersing, slurrying, plasticizing, deaerating, fiberizing, solubilizing, agglomerating, disagglomerating, pelletizing, granulating, kneading, moistening, drying, heating, cooling, stripping, impregnating, coating, waterproofing.

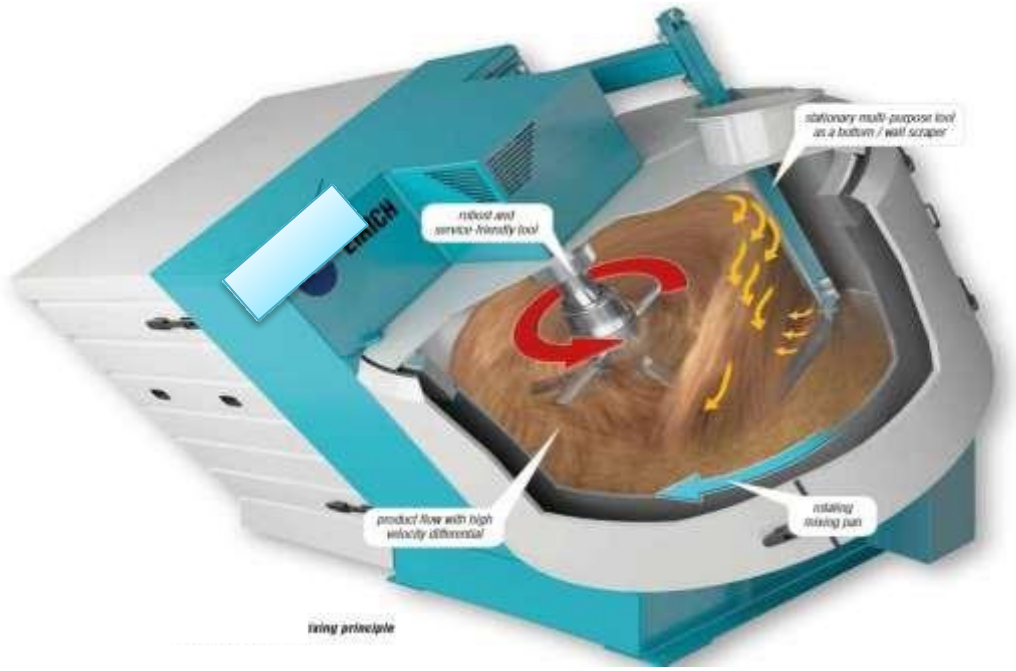


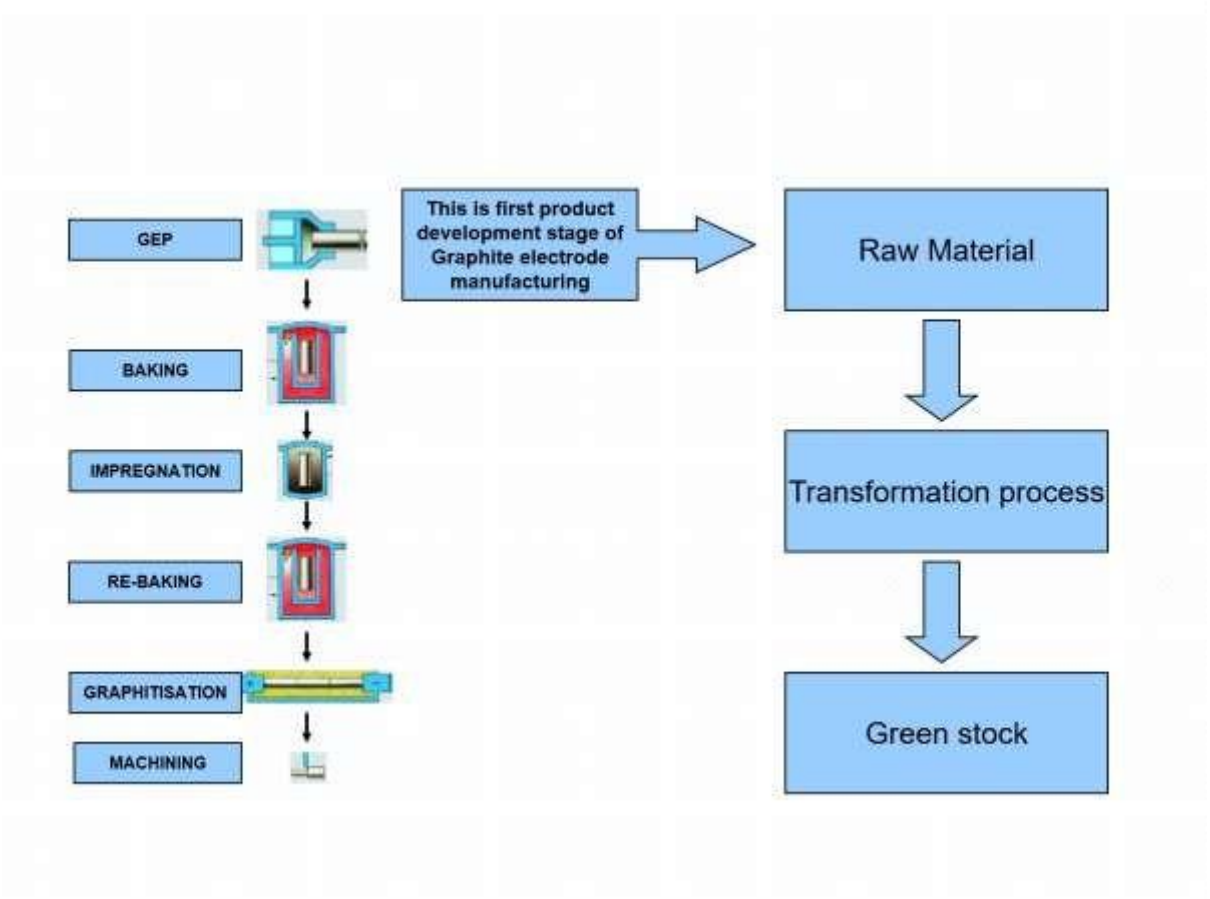
Figure 1: - Eirich mixer

II. METHODOLOGY

Graphite electrode.

The graphite electrode carries the electricity that melts scrap iron and steel, and sometimes direct reduced iron (DRI), in electric arc furnaces, which are the vast majority of steel furnaces. They are made from petroleum coke after it is mixed with coal tar pitch. There are following components of the electrode mix.

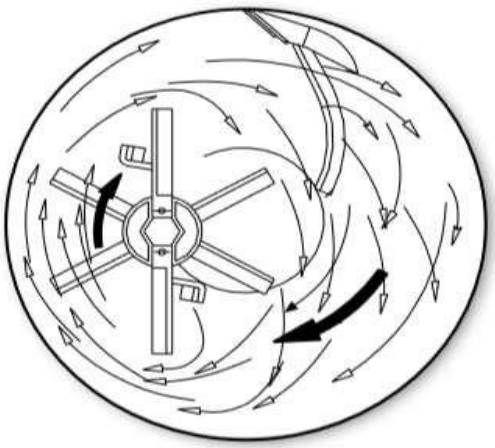
- Coke
- Iron oxide
- Green scrap
- Liquid pitch
- Stearic acid



Intensive mixer

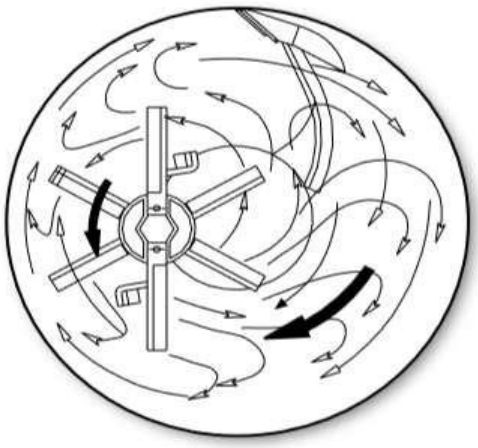
The intensive mixers can be set up for either counter-current or cross-current operation. This design provides optimum performance in both batch and continuous operation. The mixer's processing efficiency is achieved by the following features:

1. A rotating mixing pan that continually transports the material to the rotating mixing tool, including counter-flowing currents of the material with a high velocity differential.
2. The cooling point act as lubricating system which helps the mixing tool to mix properly.
3. In addition, an inclined arrangement of the rotating mixing pan achieves high vertical flow rates.
4. A multi-purpose wall-bottom scraper designed to prevent residue accumulations on the walls and bottom surface of the mixing pan and to accelerate material discharge at the end of the mixing cycle.



Flow pattern of the cross-current principle

Figure 2: - Cross-Current Flow



Flow pattern of the counter-current principle

Figure 3: - Counter-Current Flow

Causes of Failure

1. Due to the single cooling point the torque of the mixer is increased.

III. EXPERIMENTAL SETUP

The major components are a rotating mixing pan, a rotating mixing tool, adjustable wall-bottom scraper, drives, motors, feeding and discharge.

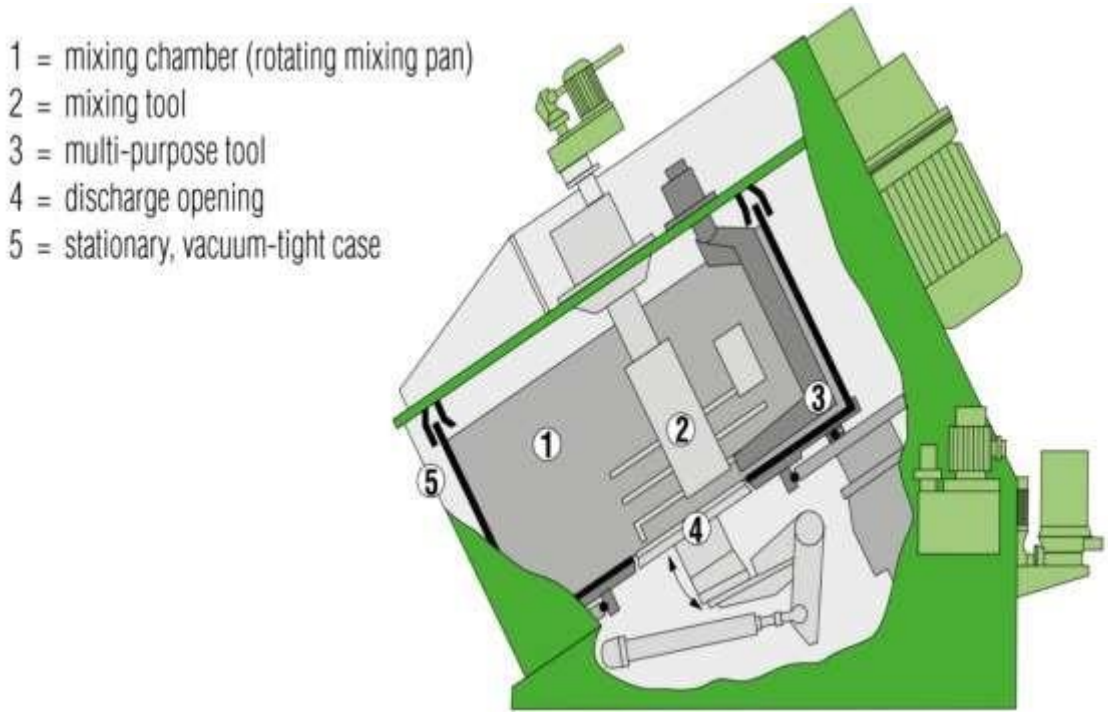


Figure 4: - Diagram of mixer

Figure 5: - Mixer tool

IV. EXPERIMENTS

Figure 6: - Eirich mixer with single cooling point

BEFORE THE EXPERIMENT: -

To carry out the experiment the raw material of graphite electrode is dropped in the mixer from the conveyor. The mixture is mixed thoroughly in the mixing chamber which is a rotating mixing pan. The mixing tool is used to mix the whole mixture. Before changing the setup or in the single cooling point the mixture was mixed but there was a slight issue such as the formation of lumps take place which directly affects the torque of the mixer. The torque of the mixer increases and the tool also gets affected resulting in the decrease in the life of the tool. This also increases the wear and tear of the mixer which increases the maintenance of the mixer. The batch weight of the mixture is also affected.

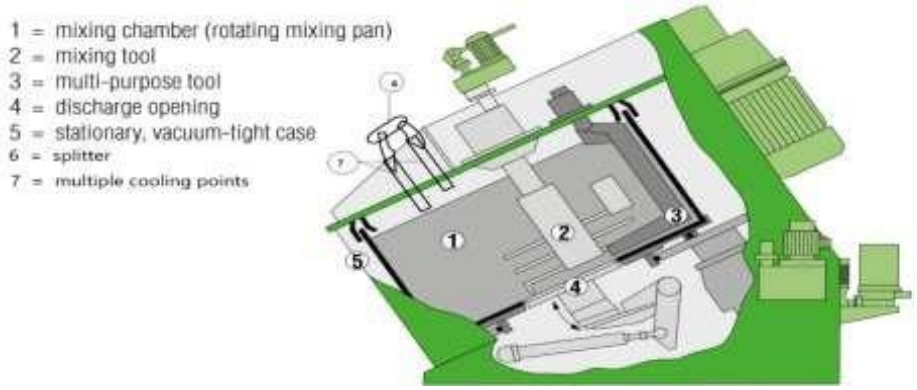


Figure 7: - Diagram of Eirich mixer with multiple cooling points

AFTER THE EXPERIMENT: -

To overcome the above problems, there was a slight change in the setup as the introduction of the multiple cooling points in the mixer. This addition of the cooling point has resulted in the increase in the efficiency of the mixer and the productivity of the plant is increased as all the problems such as the lump formation, tool life, and wear & tear of the mixer is solved.

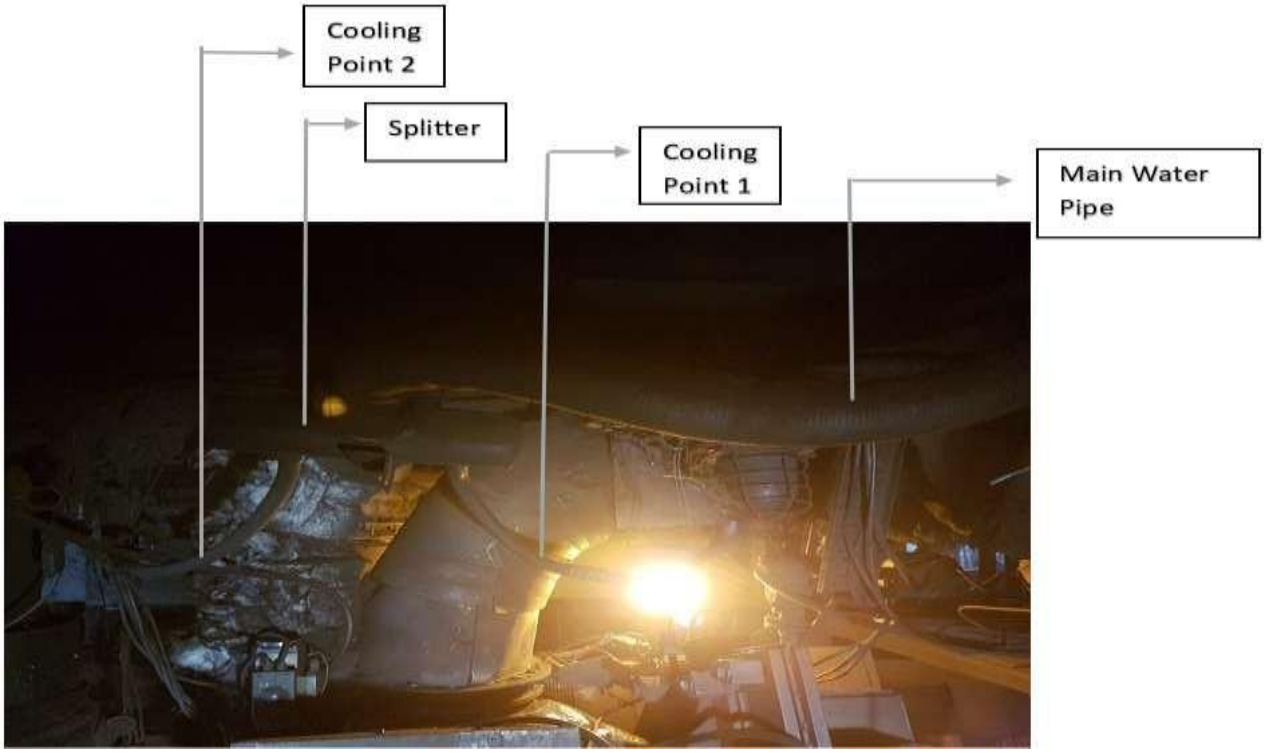


Figure 8: - Multiple cooling point setup

V. OBSERVATIONS

OBSERVATION TABLE – 1

TIME (HRS)	COOLING TIME (MIN)
07:00 AM	20
08:00 AM	22
09:00 AM	25
10:00 AM	24
11:00 AM	25
12:00 PM	23

01:00 PM	23
02:00 PM	21
03:00 PM	25
04:00 PM	21

Table 1: - Cooling time readings before changing the setup in Eirich mixer

These are the readings taken when the mixer had single cooling point setup of the mixer. In this the cooling time of the mixer was observed in which one side is time (in hrs) and the other is cooling duration of the mixture.

OBSERVATION TABLE – 2

TIME (HRS)	COOLING TIME (MIN)
07:00 AM	15
08:00 AM	18
09:00 AM	15
10:00 AM	19
11:00 AM	16
12:00 PM	18
01:00 PM	17
02:00 PM	15
03:00 PM	16
04:00 PM	18

Table 2: - Cooling time readings after changing the setup in Eirich mixer

These are the readings taken after the addition of the multiple cooling point setup of the mixer. The observation readings were taken through different hours of the clock.

OBSERVATION TABLE – 3

TIME (HRS)	TORQUE
07:00 AM	104
08:00 AM	100
09:00 AM	105
10:00 AM	108
11:00 AM	102
12:00 PM	106
01:00 PM	109
02:00 PM	104
03:00 PM	107
04:00 PM	102

Table 3: - Torque readings before changing the setup in Eirich mixer

These observation readings were taken in the single cooling point setup of the mixer. The readings were taken at different interval of time (in hrs) and the other is the mixer of the torque (in Nm).

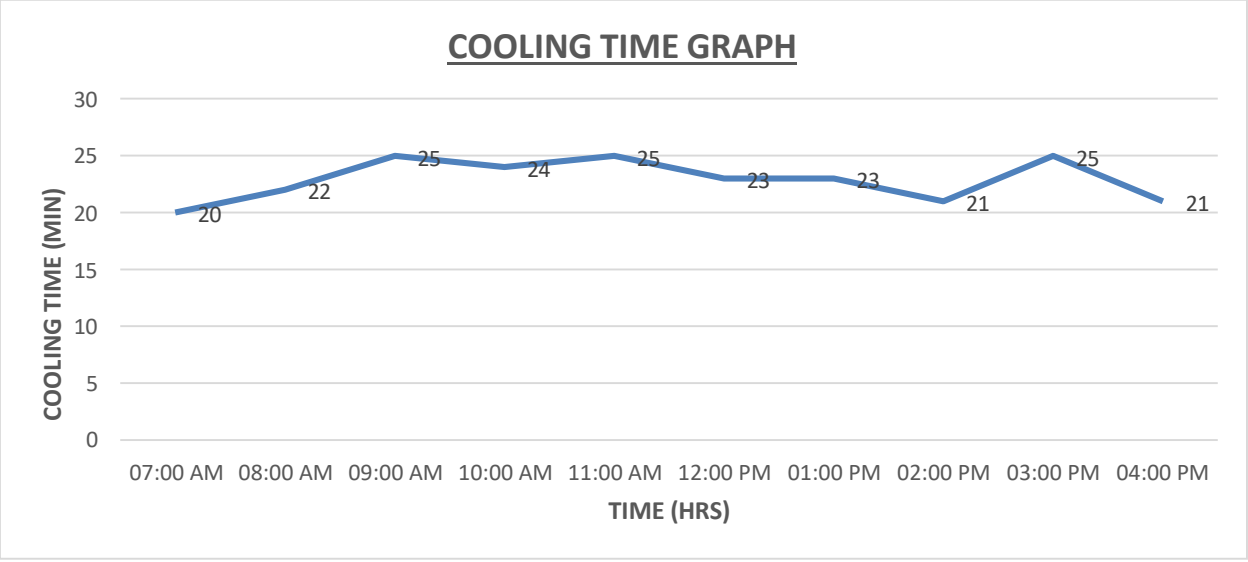
OBSERVATION TABLE – 4

TIME (HRS)	TORQUE
07:00 AM	80
08:00 AM	85
09:00 AM	87
10:00 AM	90
11:00 AM	93
12:00 PM	95
01:00 PM	89
02:00 PM	82
03:00 PM	85
04:00 PM	88

Table 4: - Torque readings after changing the setup in Eirich mixer

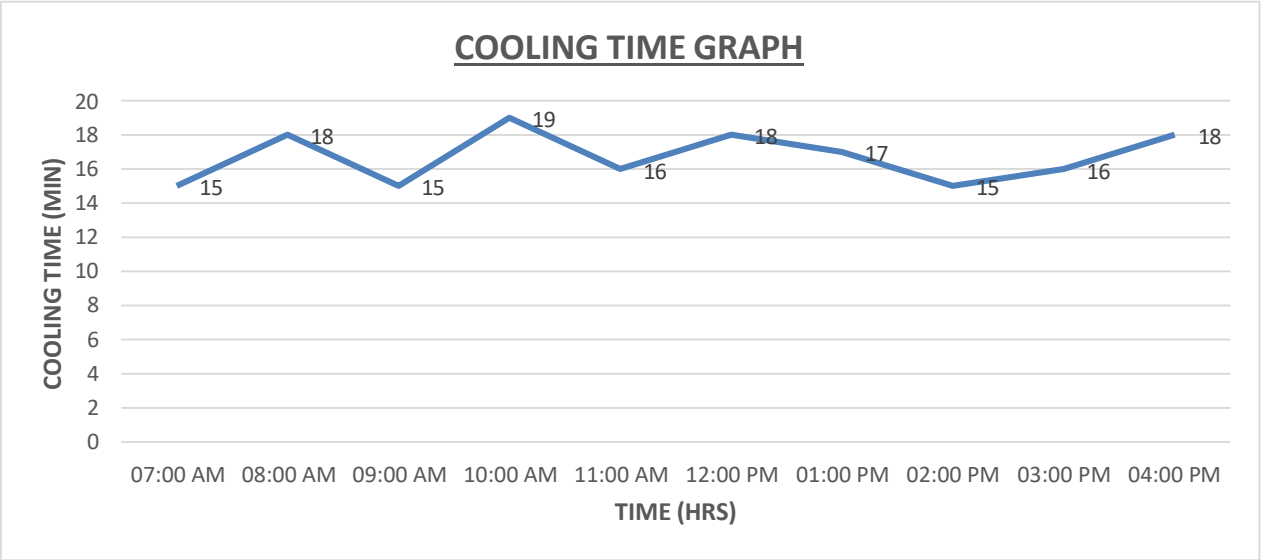
The readings are taken from the observation of the mixer after the addition of the multiple cooling point setup in time (in hrs) and the other is the torque (in Nm) of the mixer.

VI. RESULT



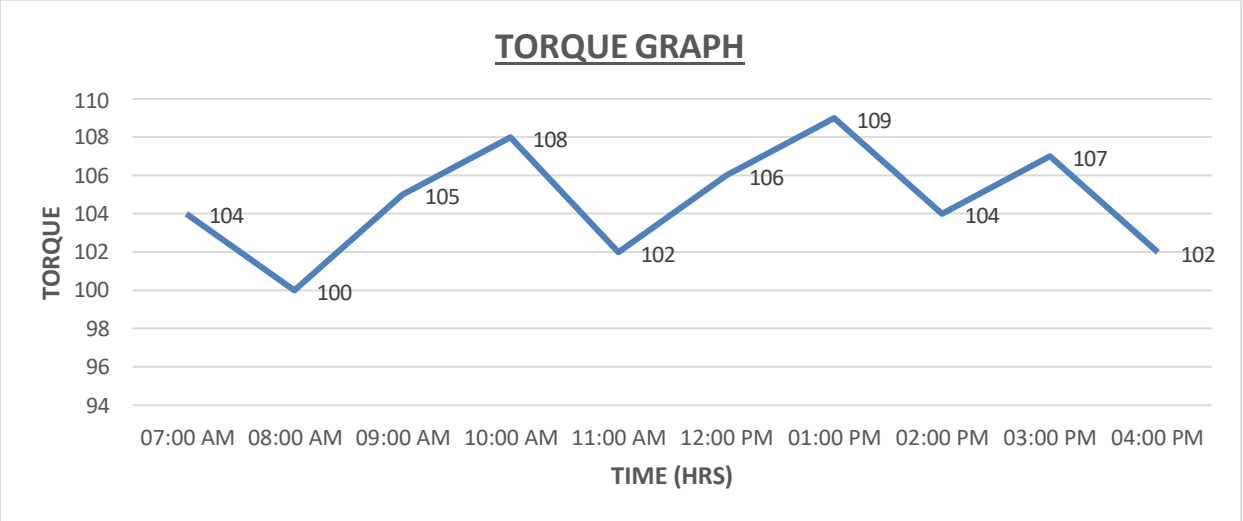
Graph 1: - Cooling time graph before changing the setup in Eirich mixer

The graph 1 is generated from the observation readings of the single cooling point in time (min) at various intervals in hrs. In this graph the cooling time of the mixer taken initially at 07:00hrs is 22mins, at 0800 hrs is 22 mins and at 0900 hrs the mixer takes the maximum time of 25 mins. This trend is followed most of the time and takes maximum duration of 25mins. The long duration of cooling time affects the production of the plant.



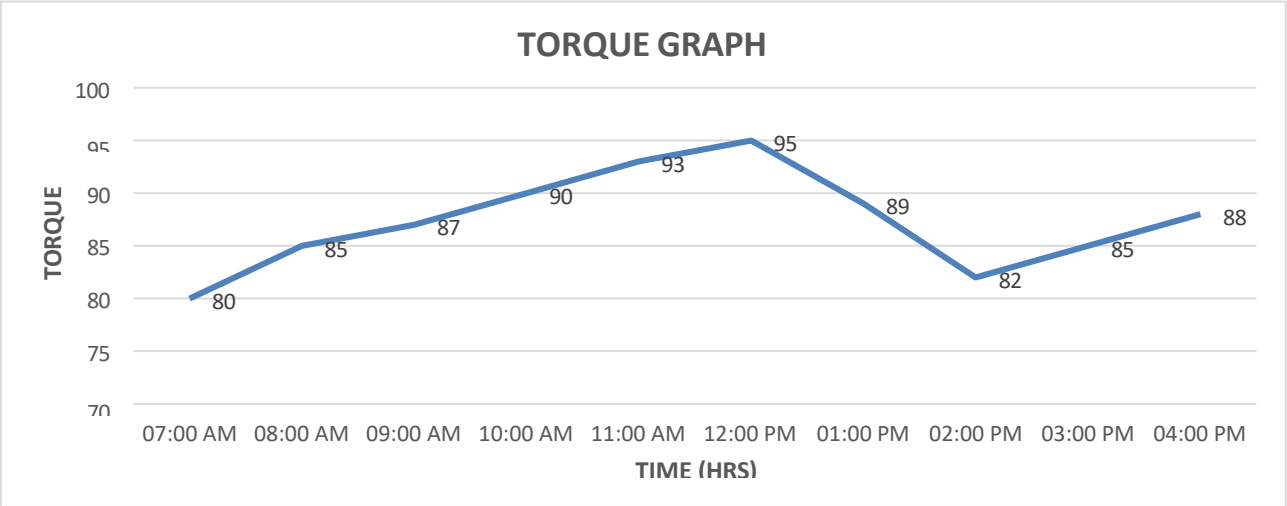
Graph 2: - Cooling time graph after changing the setup in Eirich mixer

After the addition of the multiple cooling points in the mixer graph 2 has been generated from the observation readings of the cooling time after the setup at different point of time (hrs) and the cooling duration (in mins). With the addition of more cooling points the production cycle of the plant has increased as the time taken to cool the mixer is predominantly less as compared to the single cooling point. The cooling duration then varies in the range from 15mins -20mins which is comparatively less than the single cooling point system.



Graph 3: - Torque graph before changing the setup in Eirich mixer

The graph 3 shows the variation of the torque (in Nm) at different point of time (in hrs) in the single cooling points of the mixer. In the graph 3 initially the torque at 07:00hrs is 104Nm, at 08:00 hrs is 100Nm, at 09:00hrs is 105Nm and gradually increases to 108Nm at 10:00hrs which is near to maximum torque. This increase in torque figures of up to 109Nm at 01:00hrs and so on is due to the formation of lumps that happens because of the single cooling point in the mixer which decreases the tool life and also increases the maintenance of the mixer.



Graph 4: - Torque graph after changing the setup in Eirich mixer

In the graph 4 the readings of the torque (in Nm) at time (in hrs) are taken from the observation table of the torque after the addition of the multiple cooling points. In this graph the variation of the torque is quite less than from the single cooling point. The multiple cooling points in the mixer has resulted in the decrease in the torque figures that ranges from 80Nm-100Nm as compared to the single cooling point torque figures that ranged from 100Nm-110Nm. This decrease has benefitted the plant in higher efficiency and greater productivity of the mixer.

VII. CONCLUSION

From our theoretical and experimental results, the following conclusions were drawn:

1. The addition of more cooling points in the mixer has enhanced the workability of the mixer by reducing the cooling time.
2. The torque of the mixer which was increasing rapidly is now stable and is below 100Nm resulting in the increase in tool life.

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BIOGRAPHIES

Harshit Amar has 7 years of experience and has worked at companies like Competent Enterprises, Fonty Supply Chain, HEG Ltd and ABM Knowledgeware Ltd. In 2021, he was honored with a Gold Medal by the Governor of Madhya Pradesh, Hon'ble Shri Mangu Bhai Patel. In 2024, he was recognized by Former Air Chief Marshal V.R. Chaudhari (Indian Air Force) for his contributions to policy-making.