TIME ANALYSIS OF THE MIXING PROCESS OF FIRE BRICK MATERIALS IN PT. BENTENG API TECHNIC GRESIK

Andika Puji Wirawan¹*, Zainal Arief²

¹,² Industrial Engineering Study Program, University of 17 August 1945 Surabaya
E-mail: ¹ andikapuji09@gmail.com, ² zainalarief@untag-sby.ac.id

Abstract

PT. Benteng Api Technic is a leading refractory company in Indonesia with refractory bricks as one of its superior products. The process of making refractory bricks that will be observed in this study is the process of mixing materials and the molding process. In the mixing process, there are no tools in the form of time indicators to help operators make decisions about the mixing time of ingredients. This research aims to obtain the time for the mixing of materials with maximum mixing quality and to support the press process optimally. The research was conducted using a perfectly randomized experimental design in order to obtain different mixing results based on the nine selected mixing time treatments. Measurement of working time is carried out using the stopwatch time study method on press operators who are experienced in their fields. Calculations to align the two processes using a Gantt chart with idle time as an indicator. The experimental results revealed that the most optimal mixing with a mixing time of 12 minutes resulted in 7.2 kilograms of mass that did not pass through an 18 mesh sieve. Based on the results of the gantt chart, the use of 11 mixing time for material B resulted in the lowest idle time of 178 minutes. The processing time obtained is expected to be used as a guide in determining the time input on the time indicator tool in the process of mixing refractory bricks.

Keywords: Mixing Materials, Stopwatch Time Study, Gantt Chart, Experimental Design, Idle Time

1. INTRODUCTION

Brick is a common building material, however there is a specialized variety known as firebrick that has a strong resistance to flames (Khattab et al., 2021). As a barrier against high temperatures in the combustion chamber or between high temperature manufacturing machinery and the surrounding environment, refractory brick is utilized. Because refractory bricks play a crucial role in the high-temperature production process, the production process of refractory bricks must adhere to the proper procedure. Mixing is the random distribution of materials or particles under specific circumstances and time constraints (Febrianto, 2021). In this study, the author is primarily concerned in the dispersion of the material mixture. Because it is the beginning step in the production of refractory bricks, the even distribution of the mixture during the material mixing process is deemed essential. Two workers employ a mixer machine to combine the materials.

Standard operating procedures, or SOPs, for a firm's production will ensure that every production process runs smoothly if the company has regulated its execution (Rifka, 2017). Standard operating procedures must be explicit in order to give personnel with guidance for carrying out tasks or operating machines during the manufacturing process (Leonardi, 2011). The company has established a standard time of 15 minutes, while the graph below depicts the observation time.
The impact of the time instability on the mixing process of ingredient A does not appear to have a certain effect, while in the process of mixing material B, lumps of material arise (Nguyen, 2009). After checking the humidity in the normal mass with the clotted mass, it was found that the clotted mass had higher humidity than the ordinary mass. The clumping mass has a humidity value of 70.4 RH while the ordinary mass has a humidity value of 61.3 RH.

At this time the target set by the company is 1000 bricks per machine, if one stone requires 3.9kg mass and there are 2 press machines, the mass required to meet the target is 7800kg mass. This need is fulfilled by mixing 26 times with a total time of 276.59 minutes or only using 65.8% of the available working time. Therefore, optimization can be done to get results according to production targets with minimal idle time (Asadi & Vahidi, 2010; Ghafoorpoor Yazdi et al., 2019; Montazeri-Gh et al., 2006; Shrouf & Miragliotta, 2015).

Based on the existing problems in the form of using working time that is not optimal and the emergence of lumps in material B, the research objective was set to get the process time for mixing material B with lumps that did not pass the minimum 18 mesh sieve and obtain a process that is in harmony between the mixing process and the press process. So that the research results can be used as a guide in planning and controlling the production of refractory bricks, especially in the process of mixing materials and the press process.
2. RESEARCH METHOD

A stopwatch is an instrument used to collect data on the cycle time of brick printing operators. The sieve is a piece of experimental equipment in the form of a wooden box with an 18-mesh hollow wire that is used to determine the number of lumps created during the treatment of mixing time. Observational data will be recorded and documented using stationary and mobile phones so that Excel can be used for data processing. The flow utilized in this study is as follows:

![Figure 3 Research Flow](image)

Research activities begin with field studies and literature review to determine appropriate steps to achieve research objectives. Using the stopwatch-time study method as an activity carried out to determine the standard time to complete the work, in which the measurement results will be used as a standard for completing the work (Wignjosoebroto, 2000) in (Leonardi, 2011). Using a perfectly randomized experimental design method to examine the impact of the treatment of 9 variations of mixing time on the number of agglomerates that pass through an 18 mesh sieve. Gantt charts are used to simulate the daily production process to determine the length of mixing time which creates the production process with the least idle time (Geraldi & Lechter, 2012; Kumar, 2005; Ong et al., 2016; Seymour & Hussein, 2014).
3. RESULT AND DISCUSSION

3.1. Material A Mixing Process Time

| Observation of- | Pouring ingredients (seconds) | Mixing (second) | Transfer Result (seconds) | Observation of- | Pouring ingredients (seconds) | Mixing (second) | Transfer Result (seconds) |
|----------------|-------------------------------|----------------|--------------------------|----------------|-------------------------------|----------------|--------------------------|
| 1              | 150                           | 345            | 35                       | 30             | 128                           | 454            | 42                       |
| 2              | 143                           | 438            | 56                       | 31             | 134                           | 482            | 39                       |
| 3              | 122                           | 416            | 37                       | 32             | 123                           | 503            | 31                       |
| 4              | 230                           | 519            | 42                       | 33             | 162                           | 389            | 50                       |
| 5              | 164                           | 358            | 37                       | 34             | 137                           | 420            | 39                       |
| 6              | 147                           | 377            | 38                       | 35             | 200                           | 401            | 49                       |
| 7              | 252                           | 361            | 50                       | 36             | 189                           | 428            | 52                       |
| 8              | 104                           | 421            | 54                       | 37             | 137                           | 386            | 34                       |
| 9              | 129                           | 469            | 48                       | 38             | 141                           | 430            | 31                       |
| 10             | 162                           | 809            | 39                       | 39             | 147                           | 389            | 35                       |
| 11             | 158                           | 427            | 51                       | 40             | 132                           | 524            | 37                       |
| 12             | 142                           | 402            | 32                       | 41             | 159                           | 762            | 45                       |
| 13             | 169                           | 363            | 39                       | 42             | 128                           | 312            | 39                       |
| 14             | 138                           | 379            | 49                       | 43             | 151                           | 493            | 36                       |
| 15             | 230                           | 384            | 57                       | 44             | 149                           | 418            | 31                       |
| 16             | 126                           | 316            | 38                       | 45             | 122                           | 362            | 29                       |
| 17             | 137                           | 572            | 46                       | 46             | 127                           | 346            | 46                       |
| 18             | 165                           | 398            | 41                       | 47             | 139                           | 392            | 37                       |
| 19             | 170                           | 472            | 37                       | 48             | 152                           | 507            | 36                       |
| 20             | 224                           | 435            | 42                       | 49             | 196                           | 796            | 42                       |
| 21             | 153                           | 528            | 32                       | 50             | 178                           | 463            | 37                       |
| 22             | 126                           | 423            | 32                       | 51             | 135                           | 383            | 45                       |
| 23             | 120                           | 392            | 38                       | 52             | 138                           | 390            | 41                       |
| 24             | 143                           | 374            | 35                       | 53             | 125                           | 410            | 38                       |
| 25             | 169                           | 418            | 31                       | 54             | 122                           | 492            | 57                       |
| 26             | 161                           | 429            | 39                       | 55             | 128                           | 503            | 31                       |
| 27             | 241                           | 387            | 41                       | 56             | 200                           | 386            | 36                       |
| 28             | 205                           | 689            | 37                       | 57             | 174                           | 378            | 30                       |
| 29             | 145                           | 451            | 46                       | 58             | 152                           | 692            | 32                       |
| 30             | 149                           | 400            | 42                       | 69             | 127                           | 439            | 28                       |
| 31             | 132                           | 472            | 35                       | 70             | 148                           | 533            | 41                       |
| 32             | 147                           | 469            | 39                       | 71             | 154                           | 472            | 44                       |
| 33             | 167                           | 451            | 31                       | 72             | 112                           | 526            | 36                       |
| 34             | 124                           | 539            | 42                       | 73             | 245                           | 400            | 40                       |
| 35             | 183                           | 389            | 31                       | 74             | 123                           | 385            | 35                       |
| 36             | 152                           | 389            | 35                       | 75             | 133                           | 359            | 32                       |
| 37             | 149                           | 352            | 30                       | 76             | 100                           | 493            | 45                       |
| 38             | 142                           | 421            | 37                       | 77             | 210                           | 460            | 43                       |
| 39             | 141                           | 376            | 32                       | 78             | 135                           | 365            | 27                       |

Based on the time of the mixing process for material A, the cycle time of each element is obtained. Cycle time is determined by calculating the average of each work element as follows:

\[ W_S = \frac{\sum x_i}{N} \]
Table 2 Mixing Process Cycle Time Material A

| Work Element   | Cycle Time (seconds) |
|----------------|----------------------|
| 1              | 132.4                |
| 2              | 455.3                |
| 3              | 39.1                 |
| Total          | 626.8                |

After statistical tests were carried out in the form of data adequacy tests and data uniformity tests, there was a change in the cycle time of the mixing process for material A as follows:

Table 3 Cycle Time After Statistical Test of Mixing Process of Material A (seconds)

| No. | Work Element       | Cycle Time (seconds) | N   | N'    | BKA  | BKB  |
|-----|--------------------|----------------------|-----|-------|------|------|
| 1   | Pouring Ingredients| 132.4                | 78  | 18.08 | 174.61| 90.16|
| 2   | Mixing             | 425                  | 73  | 51.4  | 596.36| 254.20|
| 3   | Transfer Results   | 39                   | 78  | 51.3  | 60.13| 18.10|
|     | Total              | 618                  |     |       |      |      |

The calculation of the performance rating and the allowance factor is only used for work elements that involve humans in most processes. Where in the process of mixing material b which is subject to performance rating and the allowance factor is work element 1, namely pouring material. The following is the performance rating table along with the allowance factor:

Table 4 Adjustment Factor

| Work Element       | Performance Rating | Allowance (%) |
|--------------------|--------------------|---------------|
| 1. Pouring Ingredients | +0.11              | 14.5          |

The calculation is continued by determining the normal time and standard time for all work elements as follows:

a. Normal Time

\[ W_n = W_s \times \text{performance rating} \]

Table 5 Standard Time for Material A Mixing Process

| Work Element   | Normal Time (seconds) |
|----------------|-----------------------|
| 1              | 146.94                |
| 2              | 425                   |
| 3              | 39                    |
| Total          | 610.94                |

b. Standard Time

\[ W_s = W_n \times \frac{100\%}{(100\% - \%\text{Allowance})} \]
Table 6 Material A Mixing Process Standard Time

| Work Element     | Standard Time (seconds) |
|------------------|-------------------------|
| 1                | 171                     |
| 2                | 425                     |
| 3                | 39                      |
| Total            | 635                     |

Table 7 Local Work Map of Material A Mixing Process Workers and Machines

| Map of Workers and Machinery |
|------------------------------|
| Work : Mixing Material B    |
| Machine name : Mixer Machine|
| Map Number : 01              |
| Operator Name : Operator 1, Operator 2 |
| Mapped By : Andika          |
| Mapping Date :              |

| Operator 1 | Time (Second) | Operator 2 | Time (Second) | Machine | Time Seconds |
|------------|---------------|------------|---------------|---------|--------------|
| Operation | Symbol        | Operation | Symbol        |         | Symbol       |
| Pouring Ingredients | 170.5 | Pouring Ingredients | 170.5 | Waiting | 170.5 |
| Wait       | 425           | Waiting    | 425           | Mixing  | 425          |
| Open the valve | 39   | Keeping Control | 39           | Transfer Results | 39  |

| Time       | Work (seconds) | Percentage (%) | idle time (second) | Percentage (%) |
|------------|---------------|----------------|-------------------|----------------|
| Operator 1 | 209.5         | 33.06          | 425               | 66.94          |
| Operator 2 | 209.5         | 33.06          | 425               | 66.94          |
| Machine    | 464           | 73.08          | 170.5             | 26.98          |

3.2. Material B Press Process Time

| Observation of- | Weighing Materials (seconds) | Press (second) | Result Setting (seconds) | Observation of- | Weighing Materials (seconds) | Press (second) | Result Setting (seconds) |
|-----------------|-----------------------------|---------------|--------------------------|-----------------|-----------------------------|---------------|--------------------------|
| 1               | 3.57                        | 15.06         | 2.56                     | 11              | 3.31                        | 15.50         | 3.16                     |
| 2               | 3.65                        | 16.02         | 2.74                     | 12              | 3.66                        | 14.80         | 3.25                     |
| 3               | 3.12                        | 13.52         | 3.02                     | 13              | 3.60                        | 16.22         | 2.98                     |
| 4               | 3.59                        | 15.52         | 3.1                      | 14              | 3.91                        | 15.02         | 3.19                     |
| 5               | 3.64                        | 15.36         | 2.53                     | 15              | 3.27                        | 16.76         | 2.32                     |
| 6               | 3.25                        | 18.76         | 2.78                     | 16              | 4.02                        | 15.10         | 2.89                     |
| 7               | 3.39                        | 15.41         | 2.43                     | 17              | 3.92                        | 15.26         | 2.67                     |
| 8               | 3.98                        | 15.52         | 2.8                      | 18              | 3.41                        | 15.36         | 2.35                     |
| 9               | 3.26                        | 15.10         | 2.86                     | 19              | 3.59                        | 14.58         | 2.94                     |
| 10              | 3.40                        | 15.57         | 2.99                     | 20              | 3.67                        | 14.26         | 3.02                     |

Based on the processing time of press material B, the cycle time of each element is obtained. Cycle time is determined by calculating the average of each work element as follows:
\[ Ws = \frac{\sum x_i}{N} \]

Table 8 Material B Press Process Cycle Time

| Work Element | Cycle Time (seconds) |
|--------------|---------------------|
| 1            | 3.56                |
| 2            | 15.44               |
| 3            | 2.83                |
| Total        | 21.83               |

After statistical tests were carried out in the form of data adequacy tests and data uniformity tests, there was a change in the cycle time of the press process for material B as follows:

Table 9 Cycle Time After Material B Brick Press Process Statistical Test

| No. | Work Element         | Cycle Time (seconds) | N  | N' | BKA | BKB |
|-----|----------------------|----------------------|----|----|-----|-----|
| 1   | Weighing Ingredients | 3.56                 | 20 |    | 8.10| 4.32|
| 2   | Press                | 15.26                | 19 |    | 3.23| 17.32|
| 3   | Result Setting       | 2.83                 | 20 |    | 14.75| 3.64|
|     | Total                | 21.65                |    |    |     |     |

Determination of the performance rating and leeway factor for all elements of work as follows:

Table 10 Material B Press Process Adjustment Factor

| Work Element           | Performance Rating | Allowance (%) |
|------------------------|--------------------|---------------|
| 1. Weighing Ingredients| +0.16              | 10.5          |
| 2. Press               | +0.09              | 9.5           |
| 3. Result Setting      | +0.09              | 8.5           |

The calculation is continued by determining the normal time and standard time for all work elements as follows:

a. Normal Time

\[ Wn = Ws \times \text{performance rating} \]

Table 11 Normal Time for Pressing Material B

| Work Element | Normal Time (seconds) |
|--------------|-----------------------|
| 1            | 4.12                  |
| 2            | 16.63                 |
| 3            | 3.01                  |
| Total        | 23.76                 |

b. Standard Time

Work Element 1

\[ Ws = Wn \times (100\%/(100\% - \%\text{Allowance}) \]
Table 12 Material B Press Process Standard Time

| Work Element | Standard Time (seconds) |
|--------------|-------------------------|
| 1            | 4.61                    |
| 2            | 18.46                   |
| 3            | 3.28                    |
| **Total**    | **26.35**               |

Table 13 Local Work Map of Workers and Machines 2 Times Press Process

| Map of Workers and Machinery |
|------------------------------|
| Work : Press                 |
| Machine name : Press machine|
| Map Number : 03              |
| Operator Name : Operator 1, Operator 2, Operator 3|
| Mapped By : Andika           |
| Mapping Date :               |

| Operator | Time (Second) | Operator | Time (Second) | Operators | Time (Second) | Press machine | Time Seconds |
|----------|---------------|----------|---------------|-----------|---------------|---------------|--------------|
|          | Operation     | Symbol   | Operation     | Symbol    | Operation     | Symbol        | Operation    | Symbol       |
| Weighing | 4.61          |          | Waiting       | 4.61      | Waiting       | 4.61          | Wait         | 4.61         |
| Waiting  | 2             |          |              |           |              |               |              |              |
| Weighing | 4.61          |          | Press         | 18.46     | Giving paper  | 2             | Press        | 18.46        |
| Waiting  | 11.85         |          | Waiting       | 16.46     |              |               |              |              |
|          | 21.74         | Press    | 18.46         |           |              |               |              |              |
| Waiting  |              | Result Setting | 3.28    | Press | 18.46         |              |              |              |
| Waiting  | 3.28          | Result Setting | 3.28    | Wait  | 3.28          |              |              |              |

| Time     | Work (seconds) | Percentage (%) | idle time (second) | Percentage (%) |
|----------|----------------|----------------|--------------------|----------------|
| Operator 1 | 9.22          | 20.58          | 35.59              | 79.42          |
| Operator 2 | 36.92         | 82.39          | 7.89               | 17.61          |
| Operators 3 | 8.56          | 19.11          | 36.25              | 80.89          |
| Machine  | 31.84         | 82.39          | 7.89               | 17.61          |
3.3. Experiment Results

Table 14 Experimental Results of Many Clumps in the Results of Mixing B Material

| Treatment (minutes) | Amount |
|---------------------|--------|
|                     |        |
| 7                   | 8      | 9    | 10   | 11   | 12   | 13   | 14   | 15   |
| Observation Data (kg) | 15.1  | 12.6 | 11   | 9.6  | 8.4  | 7.4  | 6.1  | 6.3  | 6.1  |
|                     | 14.2  | 13.2 | 10   | 9    | 7.9  | 7    | 6.2  | 5.9  | 5.5  |
|                     | 13.9  | 12   | 10.2 | 9.2  | 8    | 7.2  | 5.9  | 6    | 6.4  |
| Many Observations   | 43.2  | 37.8 | 31.2 | 27.8 | 24.3 | 21.6 | 18.2 | 18.2 | 18.2 |
| Mean                | 14.4  | 12.6 | 10.4 | 9.3  | 8.1  | 7.2  | 6.1  | 6.1  | 6.1  |
| Observational data will be analyzed for variance and Student Newmans Keuls test to determine the differences caused by each treatment.

3.3.1. ANOVA Test

Table 15 Analysis of Variance of Experimental Results

| Source of Variation | dk | JK     | KT     | EKT                | F       |
|---------------------|----|--------|--------|--------------------|---------|
| Average             | 1  | 2138.7 | 2318.7 | –                  | 11.61   |
| Treatment           | 8  | 222.96 | 27.87  | \( \sigma^2 + \sum n_i \tau^2_i / (k - 1) \) | 13      |
| Experiment Error    | 18 | 3.02   | 0.168  | \( \sigma^2 \)      | _       |
| Amount              | 27 | 2364.5 | _      | _                  | _       |

\( F_a(8,18)=2.51 \)

\( F > F_a \)

116.13 > 2.51

Based on the ANOVA calculation, it can be seen that \( F > F_a \), it is concluded that there is a significant difference caused by the difference in treatment in the experiment. Furthermore, the range test was carried out with the Newman Keuls test.

3.3.2. Newman Keuls Test

Follow-up testing to determine the significance of the difference between treatments using the average of each treatment. The average of each treatment is arranged sequentially from the largest average as follows:

Table 16 The Average Arrangement of Each Treatment

| Treatment of | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|--------------|---|---|---|---|---|---|---|---|---|
| Mixing Time  | 7 | 8 | 9 | 10| 11| 12| 13| 14| 15|
| Average      | 14.4| 12.6 | 10.4 | 9.3 | 8.1 | 7.2 | 6.1 | 6.1 | 6 |
Calculation of the average standard error for each treatment:

\[ S_Y = \sqrt{\frac{KT (Errors)}{ni}} \]
\[ = \sqrt{\frac{0.168}{3}} \]
\[ = \sqrt{0.056} \]
\[ = 0.24 \]

Retrieval of grades from the student range table with level of significance \((\alpha) = 0.05\)

- \(v = dk\) error
- \(p = 2,3,...\ k\)
- \(k = \) number of treatments

The range value obtained must be multiplied by the average standard error value for each treatment so that the smallest significant range table is obtained as follows:

| P   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| v   | 18  | 18  | 18  | 18  | 18  | 18  | 18  | 18  |
| Range value | 3 | 3.6 | 3.9 | 4.3 | 4.5 | 4.7 | 4.8 | 5   |
| RST  | 0.72 | 0.86 | 0.94 | 1.03 | 1.08 | 1.13 | 1.15 | 1.2 |

The optimal experimental result in this experiment is the last treatment that gets a difference > RST when compared to the smallest average. In the comparison table what is meant is the comparison of numbers. The last comparison that gets a meaningful difference predicate.

### 3.4. Gantt Chart

The simulation of the working process time between the mixing process and the press process is displayed in the form of a gantt chart to determine which mixing process time should be selected using variations of mixing time (Seymour & Hussein, 2014). The gantt chart is made with the following process requirements:

1) The mixing process time is the time to process 2 times until the mass container box with the mass of material B 600kg
2) Time The mixing process can be separated according to the constituent elements of time if needed.
3) The Processing Time of Press 1 and Press 2 is the same
4) The press processing time is the time to complete 1 box of mass container with a mass of material B 600kg using only 2 work elements.
5) There are 3 preparation times, namely, initial machine preparation for 10 minutes, machine preparation after a break for 5 minutes, preparation for ending production for 15 minutes.
6) There are no production activities at the time of preparation except for the completion of the process at the time of preparation for ending production.

7) The press process can only be started after the mixing process except at the beginning of the production it will be started by using the existing safety stock on the previous day.

The variation of the mixing process time used for material B is the treatment variation listed in the experimental results table, namely 7 minutes, 8 minutes, 9 minutes, 10 minutes, 11 minutes, 12 minutes, and 13 minutes, 14 minutes and 15 minutes.

The recapitulation of mixing time for material B and press time for material B with 9 variations of mixing time used in making the gantt chart is as follows:

| Table 18 Processing Time Recapitulation (minutes) |
|-----------------------------------------------|
| Mixing Time | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| Material B Mixing Time | 21 | 23 | 25 | 27 | 29 | 31 | 32 | 34 | 35 |
| Material B Press Time | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 | 47 |

After making a gantt chart using 9 variations of mixing time, the results obtained in the form of total daily production and total idle time generated for each use of mixing time.

| Table 19 Total Results |
|------------------------|
| Mixing Time | Mixing Process Result (kg) | First Press Process Results (pcs bricks) | Second Press Process Results (pcs bricks) | Total Press Process Results (pcs bricks) |
| 7 minutes | 7800 | 1000 | 1000 | 2000 |
| 8 minutes | 7800 | 1000 | 1000 | 2000 |
| 9 minutes | 7800 | 1000 | 1000 | 2000 |
| 10 minutes | 7800 | 1000 | 1000 | 2000 |
| 11 minutes | 7800 | 1000 | 1000 | 2000 |
| 12 minutes | 7500 | 994 | 918 | 1912 |
| 13 minutes | 6900 | 841 | 918 | 1759 |
| 14 minutes | 6600 | 805 | 878 | 1683 |
| 15 minutes | 6300 | 841 | 765 | 1606 |

It can be seen that the total results from the press process cannot meet the press target of 1000 bricks/machine or 2000 bricks for 2 machines if the mixing time exceeds 11 minutes.
Table 20 Total Idle Time

| Mixing Time | idle time Mixing Process (minutes) | idle time Process Press 1 (minutes) | idle time Process Press 2 (minutes) | Total Idle time of Press Process (minutes) |
|-------------|----------------------------------|-------------------------------------|-------------------------------------|------------------------------------------|
| 7 minutes   | 112                              | 83                                  | 83                                  | 166                                      |
| 8 minutes   | 91                               | 83                                  | 83                                  | 166                                      |
| 9 minutes   | 60                               | 83                                  | 83                                  | 166                                      |
| 10 minutes  | 38.5                             | 83                                  | 83                                  | 166                                      |
| 11 minutes  | 12.5                             | 78                                  | 87.5                                | 165.5                                    |
| 12 minutes  | 7                                | 86                                  | 108                                 | 194                                      |
| 13 minutes  | 0                                | 131                                 | 108                                 | 239                                      |
| 14 minutes  | 0                                | 148                                 | 120                                 | 268                                      |
| 15 minutes  | 0                                | 131                                 | 155                                 | 286                                      |

The minimum total idle time when using a mixing time of 11 minutes, the lowest idle time of the press process when using a mixing time of 11 minutes.

4. CONCLUSION

Based on the analysis, it can be concluded as follows:

1. Time changing mixing showed a significant difference in the results of the mixing that did not pass through the 18 mesh sieve. Based on the Newman Keuls test, the mixing time of 12 minutes has a maximum yield of 7.2 kilograms and has a significant difference with the smallest average yield of 6 kilograms.

2. There is a use of time mixing which produces the least idle time in the experiment using 9 variations of mixing time for material B. The use of mixing time of 11 minutes for the mixing process for material B produces the least idle time, which is 178 minutes overall. Mixing time of 11 minutes is the longest mixing time that can produce 2000 units of B bricks.

REFERENCES

Asadi, B., & Vahidi, A. (2010). Predictive cruise control: Utilizing upcoming traffic signal information for improving fuel economy and reducing trip time. IEEE Transactions on Control Systems Technology, 19(3), 707–714.

Febrianto, T. (2021). Studi Eksperimen Pengaruh Tekanan Dan Suhu Sintering Terhadap Densitas Paduan Al-Mg Dengan Metode Metalurgi Serbuk. Universitas 17 Agustus 1945 Surabaya.

Geraldi, J., & Lechter, T. (2012). Gantt charts revisited: A critical analysis of its roots and implications to the management of projects today. International Journal of Managing Projects in Business.
Ghafoorpoor Yazdi, P., Azizi, A., & Hashemipour, M. (2019). A hybrid methodology for validation of optimization solutions effects on manufacturing sustainability with time study and simulation approach for SMEs. *Sustainability, 11*(5), 1454.

Khattab, M., Hachemi, S., & Al Ajlouni, M. F. (2021). Evaluating the physical and mechanical properties of concrete prepared with recycled refractory brick aggregates after elevated temperatures’ exposure. *Construction and Building Materials, 311*, 125351.

Kumar, P. P. (2005). Effective use of Gantt chart for managing large scale projects. *Cost Engineering, 47*(7), 14.

Leonardi, P. M. (2011). When flexible routines meet flexible technologies: Affordance, constraint, and the imbrication of human and material agencies. *MIS Quarterly, 147–167*.

Montazeri-Gh, M., Poursamad, A., & Ghalichi, B. (2006). Application of genetic algorithm for optimization of control strategy in parallel hybrid electric vehicles. *Journal of the Franklin Institute, 343*(4–5), 420–435.

Nguyen, V. H. (2009). *Effects of laboratory mixing methods and RAP materials on performance of hot recycled asphalt mixtures* [Doctoral dissertation]. University of Nottingham.

Ong, H. Y., Wang, C., & Zainon, N. (2016). Integrated earned value Gantt chart (EV-Gantt) tool for project portfolio planning and monitoring optimization. *Engineering Management Journal, 28*(1), 39–53.

Rifka, R. N. (2017). *Step by Step Lancar Membuat SOP*. Penerbit Nauli Media.

Seymour, T., & Hussein, S. (2014). The history of project management. *International Journal of Management & Information Systems (IJMIS), 18*(4), 233–240.

Shrouf, F., & Miragliotta, G. (2015). Energy management based on Internet of Things: practices and framework for adoption in production management. *Journal of Cleaner Production, 100*, 235–246.
