Energy optimization and predictive maintenance of an asphalt plant: A case study.

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Abstract. This communication presents a real-life study dealing with energy optimization by using specific IoT devices in an industrial asphalt plant. The study is conducted by KANTENA TECHNOLOGIES. The objective is to demonstrate that collecting data from the plants is very valuable and useful for process optimization. The data recovered from sensors (IoT) allows us to develop a real-time supervision tool for the production system, in order to : (1) Monitor asphalt plant productions, (2) Track energy consumption and optimize its consumption, (3) Monitor the quality of service of the plant's sensitive machines while offering predictive maintenance.

1 Introduction

Among the various major sectors such as transportation, commercial, and residential, the industrial sector accounts for the largest share of energy consumption. Due to rising energy crisis, prices, and environmental issues, reducing energy consumption is not only a challenging issue, but also an important opportunity for businesses to reduce energy consumption while maintaining productivity and increasing profits [1-5]. Therefore, methods and specific energy management tools that enable the systematic analysis and optimization of energy consumption in industrial plants are very important for the industrial processes. Besides modelling and analysis questions, the use of new technologies to control and optimize energy constitutes an emerging topic. In this communication paper, a real-life demonstration about the using of IoT devices for energy optimization is presented.

KANTENA TECHNOLOGIES is an IT systems and software consulting company of the KW Group. It markets i360, which is a platform specialized in industrial computing and is positioned as a major player in the Industry 4.0 field [1-4]. It supports the digital transformation of industrial companies and offers them IoT technologies aiming to increase process efficiency, optimize risk management, and provide enhanced customer experiences. I360 INDUSTRY 4.0 transforms the customer's business in four steps: building objects, monitoring objects for real-time data collection, analysing data and making decisions. We were asked to create a tool to collect data from different production machines to control,

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manage and optimize energy consumption and ensure efficient predictive maintenance. To carry out this project, we have mapped and audited the operation of the asphalt plant; understood the operation of the production processes; determined all the necessary data to optimize the energy consumption and to manage predictive maintenance of the industrial system. According to the system, some transformation by using IoT devices and intelligent sensors are proposed, and their efficiency for energy optimization [7] and maintenance management [6] purposes is tested. In the rest of this article, a short summary of the study is presented. For reasons of confidentiality of some data and tools, more details will be given during the oral communication.

2 Area of Study

As a case study, we consider asphalt plant, an independent nationwide group, shown in Figure 1. Its intermediate size allows it to be both reactive and flexible to satisfy its customers. Since its creation, it has ensured the control of its industrial tools, which guarantee its independence and essential levers of its innovation strategy. It produces high-quality asphalt mixes and asphalt at competitive prices for its customers.

With a vision focused on factory 4.0, this company wishes to exploit new technologies, including IoT devices, in order to modernize its production and maintenance processes while optimizing its energy consumption. In the rest of this article, we present our proposed technological solutions in this context.

Fig. 1. Industrial asphalt plant (Case study)

3 Methodology and solutions

Firstly, an Audit and several interviews with the company are conducted in order to understand the client's activity and to propose an activity and a manufacturing process diagrams. At the end of the Audit, we have:

- Collected and analysed Electricity and Gas bills from 2020 and 2021.
- Targeted production machines with high energy consumption.
- Selected a set of adapted and specific energy sensors.
- Validated the choice of energy collectors

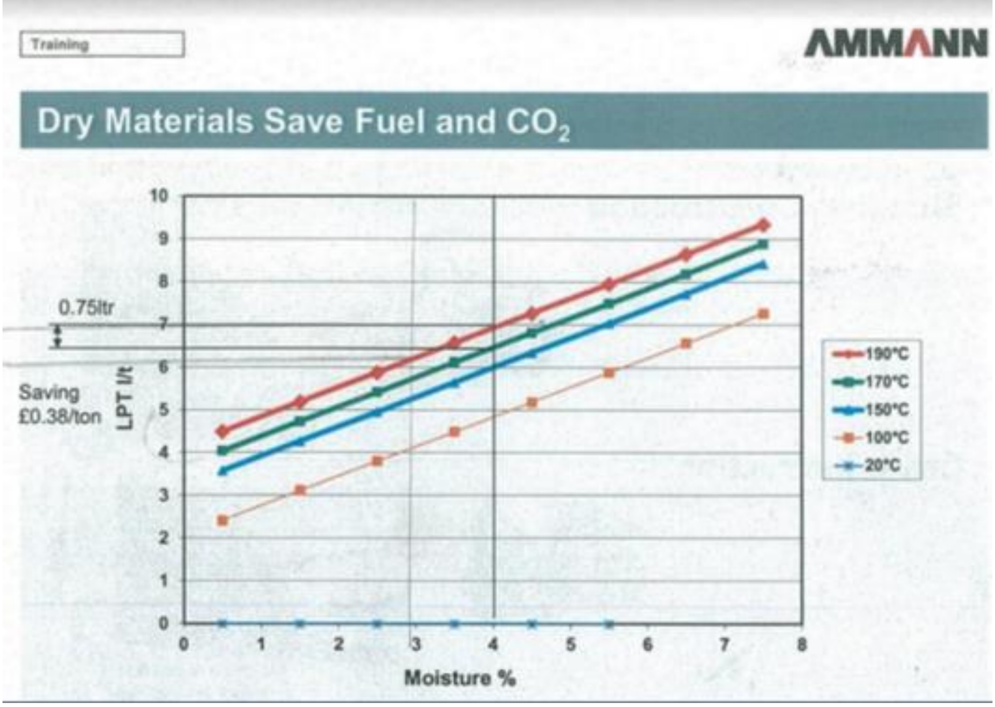
- Localized entities in the manufacturing process where it is possible to integrate the IoT devices and sensors.
- Developed techniques for energy consumption control and optimization.
- Developed a real time Dashboard for supervision and monitoring energy of the asphalt plant (Energy monitoring)

4 Technological solutions and results

4.1 Energy control and optimization

The Kantena Technologies team proposes to equip the plant with smart sensors for measuring and monitoring the energy consumed by the production process and its infrastructures. We have chosen to use an energy sensor of "**LoRa**" type, allowing to monitor the energy consumption of the machine to be supervised. According to our audit, to optimize energy consumption up to 20%, some pratical recommendations need to be considered:

- Reduce the humidity of materials by ensuring their optimal conditioning (their storage must be imperatively done under sloping platform and put them under shelter),
- Raise awareness among all the plant's staff on the impact of this humidity in relation to productivity (see Figure 3).
- Recover and exploit the fumes generated by machines and set up a turbine for power generation
- Use variable frequency drives on large motors that can operate at reduced speeds without impacting the manufacturing process and depending on production conditions.



 https://doi.org/10.1051/e3sconf/202235302004

Fig. 3. Energy consumption curve as a function of humidity level.

4.2 Predictive maintenance management

Otherwise, predictive maintenance is a part of this study in order to anticipate machine breakdowns. Our objectives are:

- ✓ Reduction of at least 90% of unplanned downtime
- ✓ Decrease in the frequency of failures
- ✓ Reduction of at least 10% in maintenance costs
- ✓ Facilitate the determination of the type of possible fault (macro-micro)

To perform such objectives, sensors to measure vibrations in some machines are proposed. [6]

4.3 Real-Time dashboards

As shown in Figures 4 and 5, based on the set of proposed sensors and their connectivity (IoT), a monitoring dashboard was developed as shown in the following figures.

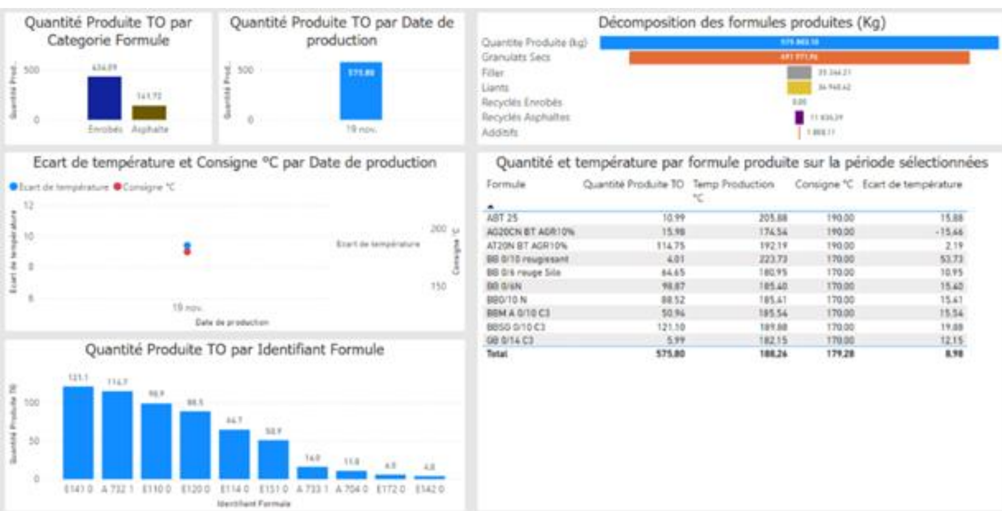


Fig. 4. Production data by period.

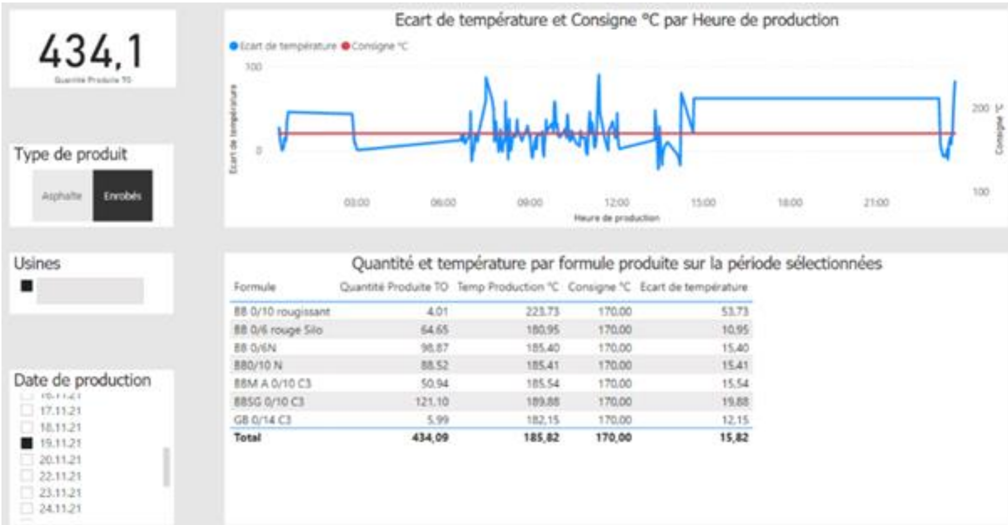


Fig. 5. Production data by fixed date.

5 Conclusion

In recent years, with the massive increase in energy consumption and its dangerous consequences on the climate change on the one hand, and the real-time knowledge of the health status of production machines on the other hand, industries are pushed to improve their production processes and their maintenance policies. In this context, research on energy optimization and predictive maintenance has attracted great interest in the last decades. Among these issues, production supervision and an overview of the health status of the machines are the key tools to achieve an economically and energetically optimal production system. In this context, our study proposes a solution that solves the mentioned problems and these results obtained seem very encouraging for the customer.

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