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ARTIFICIAL INTELLIGENCE-ENABLED GREEN MANUFACTURING OF MOLDED FIBER PRODUCTS

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Abstract:

Green manufacturing is slowly becoming imperative. This not only has an impact on the environment but also on the sustainability of the businesses. Ensuring efficient consumption of resources has a direct impact on profits. With end-users also becoming more conscious, adhering to sustainable practices improves the brand image and thereby increases market share. Haber has been able to assist the paper industry in implementing and ensuring greener practices via its artificial intelligence-based services. This paper explores in detail how this has been achieved in the upcoming molded fiber products industry.

Keywords: Artificial Intelligence, Machine learning, electricity consumption, sustainability, molded fiber products

Introduction:

Sustainability has become a critical decision-making factor for individuals, governments, and industries. The efforts of each one have a compounded impact on society. It has driven innovation to produce new products, develop new technology to support greener production, adopt new sustainable raw material sources, change consumption patterns, and introduce and implement stricter laws. In short, it has made businesses rethink their entire value chain.

Ensuring a greener world or new business opportunities was not the only driving force for businesses. They also noticed that adopting greener manufacturing methods such as recycling, reusing and renewable sources of raw material, and efficient use of resources has led to a reduction in costs and improved their profitability. [1]

Molded Fiber Products:

In recent days there has been a sharp increase in the use of paper packaging as an alternative to plastic, especially single-use plastic. It also led to innovation within the paper industry. It gave rise to molded fiber products which are made of agro residues or recycled material. This has been used by consumer durables, food and beverage, and many other industries. The market is expected to grow with a CAGR of 5% [2].

This industry supports the drive towards achieving sustainability. Any technological intervention which improves the efficiency of the industry can have a huge cascading impact on the environment. Thus the molded fiber industry has a huge scope for improvement.

Green Manufacturing in Molded Fiber Products

Manufacturers are still experimenting at their own end to overcome a few challenges, and make it adaptable to suit various conditions. An intervention by artificial intelligence can improve the industry and drive green manufacturing. It can significantly reduce raw material consumption, and energy consumption and make the product more environmentally friendly.

The production process begins with the fiber treatment process and then reaches the critical stage of the molding process. Excelling at this stage becomes important as critical properties like oil proofing, waterproofing, and stiffness are impacted by density and moisture content. Manufacturers face several issues, like quality variation, reduced machine runnability due to higher cycle time, etc. when the moisture content is not within the desired range [3]. This certainly is a critical challenge. It also leads to higher quality rejects.

At Haber, through our Artificial Intelligence-Machine Learning-driven services, we strive to achieve both efficiency and sustainability. The application of our solutions solves the critical challenges faced by the molded fiber products industry. Our solution drives efficiency and ensures one produces more with fewer resources. When implemented in a segment that in itself is aimed at driving sustainability, the industry experiences an amplified impact and that's how Haber aims at driving green manufacturing.

eLIXA®, our Artificial Intelligence-Machine Learning-driven device, has a particular focus on the mechanical, operational, and chemical aspects to drive production rate and product quality while ensuring optimal resource utilization.

Optimal resource utilization across several stages in the production process has been achieved by eLIXA® [4]. This paper would focus on one such instance.

When applied for retention and drainage aid, artificial intelligence has achieved significant cost reductions and improvement in quality.

Methodology:

The study was conducted at one of the leading tableware manufacturers, which produces molded products in the range of 100 to 400 GSM using agro residue. The study was carried out for 20 days. The client was facing productivity and quality issues for a long time affecting their production lines.

1. The goal of the program was to achieve an increased drainage rate to improve machine runnability while retaining fines and minimizing quality variation.

2. We began with recording data in real-time via sensors such as pH, conductivity, and temperature.

3. In addition to real-time data, we also combined various data collected from the DCS such as grade, grammage, degree of refining, cycle time, moisture, press loads, vacuum level, drying temperature, and offline data from the data book like furnish, charge demand and consistency.

5. The data was used to identify variables that have the maximum impact on the drainage rate.

6. The relationship between these key variables was then understood to build an ML-based model and algorithm to predict the drainage rate in real-time and the chemical dosing thereof.

Results:

RDA program, when enabled with artificial intelligence-machine learning models, helped to control chemical dosing in real time and achieve improved drainage rate. Deviations in product quality were also minimized which were achieved with the artificial intelligence-machine learning model. This had the following significant impact on the process.

1. eLIXA ® driven RDA program has improved the FPR rates by 5% and has helped to maintain consistency in the results.

   1A. Optimal retention meant that the usage of chemicals (like oil proofing chemicals that are used in the manufacturing of molded products) to achieve oil proofing has significantly reduced from 1.8% to 1.4%.

   1B. Reduction in consumption levels of fluoro chemicals improves the ease of decomposition, giving a significant boost to sustainability.

   1C. International markets have strict control over the fluoro chemicals usage levels as they alter the decomposability and are also used for food-grade packaging. A reduction in that opens the international market.

2. Artificial Intelligence-driven RDA program led to an improvement in drainage by 15% (Fig. 1). This led to an increase in production by 0.5 Ton/day.

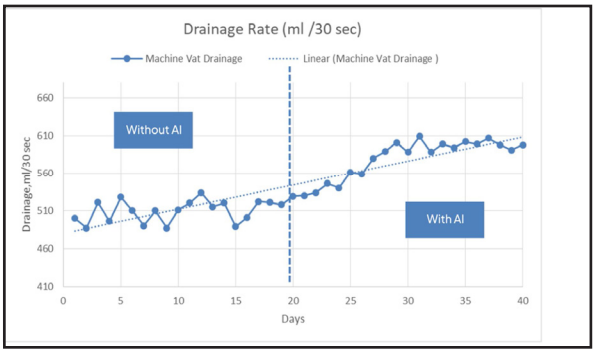

Fig. 1: Drainage profile as a function of time

   2A. Better drainage results in lesser steam consumption and this led to a reduction in steam usage and hence reduced energy consumption as well.

   2B. Artificial Intelligence-driven RDA program led to the reduction of the vacuum load and thereby reduced energy consumption.

   2C. A quicker movement through the drying stage also means an increase in production rate and reduced cycle time.

3. It also helped to achieve consistent moisture content, waterproofing, and oil-proofing in the final product and reduced quality rejects.

Conclusions

The artificial intelligence based process control has helped to ensure maximum efficiency through sustainable means. It has promoted green manufacturing practices in the molded fiber segment and can have a huge impact on the society. It has had an impact on both the end product and the resource utilisation. It has made the product decomposable and also reduced the cost by driving down the chemical usage. It has also had an impact on the production rate having a direct impact on the revenue potential. It has also reduced electricity and steam consumption thereby driving down the resource requirement and making the process more sustainable.

Abbreviations

- AI: Artificial intelligence
- ML: Machine learning
- RDA: Retention and drainange aid
- FPR: First pass retention
- DCS: Distributed control system

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