Business Plan for the Industrial Application of an Intelligent Three-Ring Kiln for the Activated Calcination of Magnesite

This business plan details an industrial project for the activated calcination of magnesite to produce high-quality caustic calcined magnesia (CCM), utilizing the HNS series Intelligent Three-Ring Kiln—a large-scale patented equipment with independent intellectual property rights—and its associated activation calcination technology, developed by Shandong Hening Shun Kiln Industry Co., Ltd. Currently, China's magnesite calcination industry, particularly in major high-grade magnesite-producing regions like Liaoning, still predominantly relies on thousands of traditional reverberatory kilns. These kilns are plagued by numerous issues, including low output, high energy consumption, severe pollution, and a low degree of automation, rendering them incapable of meeting the nation's stringent requirements for energy conservation and environmental protection, as well as the market's demand for high-quality products.

The Intelligent Three-Ring Kiln, as a new type of digital kiln integrating high efficiency, energy savings, intelligent control, and environmental friendliness, offers a revolutionary solution for the technological upgrading of the magnesite calcination and refractory materials industry. This project aims to replace multiple outdated traditional kilns with a single Intelligent Three-Ring Kiln. Through its disruptive "activation calcination" and "smothering and homogenization" processes, efficient closed-loop energy system, and full-process intelligent control, it will achieve large-scale, high-quality, and low-cost production of caustic calcined magnesia.

The core output of the project is a highly active light-burned magnesia powder with a stable residual loss on ignition (LOI) of less than 1%. The product quality is comparable to that of internationally advanced kiln types and can be directly used for producing high-purity magnesia and other high-end refractory materials. Compared to traditional processes, this project holds an overwhelming advantage in terms of output, energy

consumption, labor costs, and environmental protection. With an estimated investment payback period of just 1.4 years, it promises outstanding economic benefits and enormous market potential. Concurrently, by promoting the green transformation of the industry, the project will generate significant social and environmental benefits, representing a key initiative for practicing the concept of "new quality productive forces" and achieving sustainable industry development.

1. Project Overview and Technical Advantages

1.1 Project Background and Industry Pain Points

Magnesite is the key raw material for producing high-purity magnesia powder and magnesian refractory materials. However, the processing segment of this industry has long faced severe challenges. Taking the magnesia refractory industry cluster in Liaoning as an example, the existing thousands of light-burning magnesia reverberatory vertical kilns are all traditional, old-fashioned earth kilns. Their crude production methods lead to wasted mineral resources and severe environmental pressure. The core pain points of these traditional kilns include:

Outdated Process, Uneven Quality: Uneven heating often results in under-burning or over-burning at the core of the product, leading to highly unstable product quality, with a loss on ignition typically ranging from 3-8%.

High Energy Consumption, Low Efficiency: Thermal efficiency is generally below 50%, resulting in high energy consumption per ton of product and low production efficiency.

Severe Pollution, Harsh Environment: Dust and sulfur dioxide emissions seriously exceed standards. Manual discharge methods lead to poor working conditions and high labor intensity.

Low Automation, Reliance on Labor: The entire process from feeding to discharging relies heavily on manual labor, making it difficult to achieve large-scale, continuous production.

These problems have severely restricted the healthy development of the industry, making technological upgrading an urgent necessity.

1.2 Technical Solution: The Intelligent Three-Ring Kiln

To systematically address the aforementioned pain points, Shandong Hening Shun Kiln Industry Co., Ltd. has developed the HNS series Intelligent Three-Ring Kiln with independent intellectual property rights. This kiln is a new type of furnace with a novel structure, characterized by energy efficiency, environmental friendliness, high output, and full-process digital intelligent control, representing a complete replacement for traditional kilns.

1.3 Core Technical Advantages

The superior performance of the Intelligent Three-Ring Kiln stems from its systematic innovations in thermal engineering, control, energy conservation, and environmental protection.

"Smothering and Homogenization" Process & Superior Product Quality: This is the kiln's most critical technical highlight. A tube-type heat exchange device is added to the enlarged cooling zone at the bottom of the kiln body. The finished product remains in this area for 24 to 36 hours, achieving a special process effect of "smothering and homogenization." This process ensures the continued decomposition of any not-yet-fully-decomposed magnesium carbonate ($MgCO_3$), resulting in a final product with a **stable residual loss on ignition (LOI) of less than 1%**. This fundamentally solves the industry-wide problem of incomplete core activation in lump materials from traditional processes, yielding product quality comparable to internationally advanced kiln types like the Maerz kiln.

High Energy Efficiency & Closed-Loop Thermal System:

Four-Stage Waste Heat Closed-Loop Circulation: The system creates an efficient closed-loop for thermal energy. High-temperature flue gas preheats the incoming ore, and low-temperature waste gas can drive a waste heat boiler for power generation (e.g., with a 3.2MW unit). The final exhaust gas temperature is below 130°C.

Ultimate Energy Efficiency: The comprehensive thermal efficiency reaches as high as 78%, far exceeding the sub-50% level of traditional kilns. Specifically for magnesite calcination, the energy consumption per ton of product is only 125 kg of standard coal, a **39% reduction** compared to the 205 kg of standard coal for traditional kilns.

Intelligent Robotic Discharging & Massive Capacity Increase:

Unmanned Operation: An intelligent robot equipped with far-infrared sensors performs 24-hour, fully sealed discharging, replacing 80% of manual operations. The robot can accurately sense the calcination status of the material and adaptively adjust the extraction force to ensure product quality.

Significant Efficiency Boost: Compared to manual discharging, the intelligent robot can **increase output by three to five times or more**. The discharging process is fully sealed, eliminating dust and heat loss at the source.

Full-Process Digitization & Precise Control: The entire process, from proportioning and feeding to discharging, is automated. Key parts of the kiln are densely fitted with various sensors to achieve the "four modernizations" management goals: "precision in material calcination, digitization of product quality, safety of personnel and equipment, and cleanliness of the site environment."

2. Market Analysis and Positioning

2.1 Market Opportunity

As national standards for environmental protection and energy consumption become increasingly strict, and as downstream industries demand higher-quality refractory materials, a large number of existing traditional kilns face elimination. This creates a huge market replacement space and development opportunity for the technologically advanced, energy-efficient, and environmentally friendly Intelligent Three-Ring Kiln.

2.2 Target Market

The target market for this project primarily consists of magnesite mining and refractory material production enterprises that have high requirements for product quality, environmental standards, and production efficiency. These companies need a stable supply of highly active, low-LOI light-burned magnesia to produce high-purity magnesia, mid-grade magnesia, magnesia-alumina spinel, and other high-end synthetic refractory materials, thereby enhancing their products' added value and market competitiveness.

2.3 Competitive Advantage Analysis

Versus Traditional Earth Kilns: The Intelligent Three-Ring Kiln achieves a "qualitative leap" in output, quality, energy consumption, environmental protection, and automation, making it a complete replacement solution.

Versus Other Advanced International Kilns (e.g., Maerz Kiln): While ensuring comparable product quality (LOI < 1%), the Intelligent Three-Ring Kiln offers comprehensive advantages such as **greater investment cost-effectiveness, smaller footprint, and higher production capacity**, providing investors with a more economical choice.

3. Production and Operations Plan

This plan is based on the technical transformation project of a group in Liaoning, which involves dismantling 12 old kilns and building one new HNS-5300S Intelligent Three-Ring Kiln.

3.1 Production Capacity

A single HNS-5300S kiln can achieve a **daily output of 380 tons (±7%)**, which is more than ten times the output of a traditional earth kiln.

3.2 Process Flow

1. **Raw Material Preparation:** Magnesite lumps are graded into specifications such as 25-50mm, 50-100mm, and 100-200mm to achieve optimal roasting effects.

2. **Automatic Feeding:** An automatic proportioning system and a feeding cart evenly add the ore into the preheater at the top of the kiln.

3. **Gradient Calcination:** The material moves from top to bottom through the preheating zone, the firing zone (700-1000°C, residence time 6-8 hours), and the cooling zone, ensuring full decomposition of $MgCO_3$.

4. **Intelligent Discharging:** The calcined light-burned magnesia powder is pushed by the intelligent robot into the smothering layer under sealed conditions. After thorough homogenization and cooling, it is discharged from the bottom of the kiln.

5. **Finished Product Handling:** The temperature of the discharged product is approximately ambient temperature +65°C. It is transported via a closed belt conveyor to a silo or a briquetting workshop in a dust-free and environmentally friendly manner.

3.3 Product Positioning and Quality

Core Product: High-activity caustic calcined magnesia (CCM).

Quality Standard: Residual loss on ignition (LOI) is stably below 1%. The product has excellent sintering activity and a high briquetting rate, making it an ideal raw material for preparing high-purity and mid-grade magnesia.

4. Business Model and Financial Analysis

4.1 Business Model: Building "Triple Revenue"

This project breaks the traditional industrial model of relying on single-product profit by constructing a more diversified "triple-revenue" economic model.

Product Profit: Core income is generated from the production and sale of high-value, high-quality light-burned magnesia powder.

Government Subsidies: As an advanced project for energy conservation, environmental protection, and comprehensive resource utilization, it is expected to receive financial support from national and local governments.

Carbon Trading Revenue: The significant energy-saving and emission-reduction effects (e.g., 39% energy saving in magnesite calcination) and the potential for CO_2 capture can generate additional income in the carbon trading market.

4.2 Profitability Analysis

Revenue Side: Output is increased by more than tenfold, and the excellent product quality allows for positioning in the high-end market, achieving higher sales prices and profit margins. For low-grade ore, the technology can increase its added value by a factor of 10.

Cost Side:

Energy Costs: The energy cost per ton of product is significantly reduced. For instance, the cost of calcining magnesite can be lowered from over 400 RMB to 255 RMB.

Labor Costs: Automated production can save 80% on labor.

Environmental Costs: Emissions are far better than national standards, eliminating the need for massive additional environmental retrofitting investments.

4.3 Investment Return Analysis

Combining low costs, high output, and diversified revenue, this project demonstrates extremely strong profitability. Based on calculations from similar magnesite calcination projects, the **investment payback period is only 1.4 years**, highlighting its outstanding economic benefits.

5. Social and Environmental Benefits

5.1 Economic Benefits

It drives the transformation of the refractory materials industry from crude production to a green, low-carbon, and intelligent "new quality productive force," enhancing the utilization value of mineral resources and the core competitiveness of enterprises.

5.2 Social Benefits

It replaces traditional high-risk, high-pollution manual working environments with intelligent and clean production environments, greatly improving workers' labor conditions and enhancing their dignity and safety.

5.3 Environmental Benefits

Energy Saving and Emission Reduction: Replacing multiple old kilns with one new kiln drastically reduces energy consumption per unit of product and directly lowers carbon emissions.

Pollution Control: It eliminates dust at the source. SO_2 emissions are below 35mg/m³, and dust emissions are below 8mg/m³, both significantly better than national standards, effectively protecting the ecological environment.

Land Conservation: Replacing multiple kilns with a single one effectively saves valuable land resources.

6. Conclusion

Through its systematic innovations in **precision activation, ultimate energy efficiency, intelligent control, and ultra-low emissions**, the Intelligent Three-Ring Kiln technology provides a "Chinese solution" for the magnesite calcination industry that is simultaneously economical, environmentally friendly, and strategic.

By applying this technology, this project will not only bring substantial economic returns and an extremely short investment payback period to the enterprise but will also lead the technological innovation of the entire industry, driving it towards high-quality, sustainable development. Its implementation will successfully solve the long-standing problems of energy consumption, environmental protection, efficiency, and quality in traditional processes, and it is supported by solid technology, broad market prospects, and a significant role as an industrial demonstration leader.