Circular Economy Supporting Green Transition of Chemical Industry:

——From key element utilization to industrial chain synergies

Abstract: In response to growing resource and environmental pressures and the urgent need for carbon reduction, the chemical industry must urgently identify viable pathways for green transition. Fuhua Tongda Chemical Co., Ltd., has established a circular industrial chain centred on key elements such as phosphorus, chlorine, and sodium. This approach has enhanced resource efficiency and promoted cleaner production. Phosphorus utilization efficiency has increased from 67.8% to 99.8%, while that of chlorine has risen from 87.7% to 92.4%. Meanwhile, through initiatives such as the resource recovery of organic waste liquid, reinjection of dilute brine into salt mines, and comprehensive utilization of by-products, the company has significantly reduced both resource consumption and carbon emission intensity.

Keywords: Elemental Economics; Circular Industrial Chain; Green and Low-Carbon Transformation of the Chemical Industry

1. Background

The chemical industry is a major contributor to global carbon emissions. In China, the sector remains largely characterized by high energy consumption and linear resource utilization. Problems such as resource waste and by-product disposal have posed serious constraints on green and low-carbon development. Under the drive of carbon reduction targets, the circular economy has emerged as a crucial approach for promoting green and low-carbon transformation in the chemical industry.

Fuhua Tongda Chemical Co., Ltd. (hereinafter referred to as Fuhua Chemical), a private chemical enterprise, has positioned circular economy design and ecological protection as key drivers of its competitiveness since 2004. Advancing the concept of Element Economics and, through technological innovation, Fuhua continuously improved the resource utilization of by-products and the deep processing methods of intermediates. Furthermore, it has built a three-dimensional industrial chain centred on key elements such as phosphorus, chlorine, and sodium, thereby increasing the added value of its products and improving resource utilization efficiency.

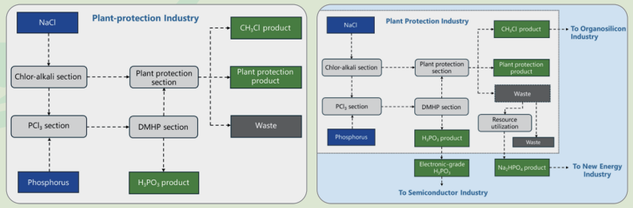

Figure 1. The development trajectory of Fuhua Chemical's business segments. Left: Business areas before circular economy practices. Right: Business areas after circular economy practices

2. Main Practices

(1) Extending the Industrial Chain Driven by Elemental Economics

· Developed an innovative "thermal process" that converts organic phosphorus wastewater and low-value industrial salt into high-value disodium hydrogen phosphate, achieving zero discharge of organic-source phosphogypsum.

· Expanded the range of phosphorus-based products from two to four, with total revenue increasing nearly fivefold.

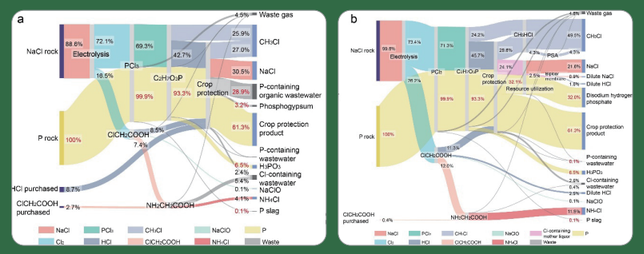

Figure 2. Elemental balance of phosphorus and chlorine in Fuhua Chemical. Left: Before recycling utilization. Right: After recycling utilization

· Applied bipolar membrane electrodialysis and pressure swing adsorption (PSA) technologies, raising the recovery rate of chloromethane from 92% to 99%.

Figure 3. Chloromethane PSA unit and spherical tank
(Credit: Fuhua Tongda Chemical Co., Ltd.)

(2) Recycling Dilute Brine to Achieve Water Conservation and Carbon Reduction

· Eliminated evaporation unit and reinjected dilute brine into salt mines, reducing freshwater consumption per ton of caustic soda from 5 tons to 1 ton.

· Achieved annual carbon reduction of approximately 208,000 tons CO_2-equivalent.

Figure 4. Dilute brine recycling process
(Credit: Fuhua Tongda Chemical Co., Ltd.)

(3) Designing Cross-Enterprise Resource Recycling

· Recycled on-site brine sludge together with nearby enterprises' waste ("white sludge") as a substitute for limestone in desulfurization at the park' s thermal power plant, reducing carbon emissions by about 15,000 tons annually.

· Saved approximately RMB 9 million annually in raw material procurement and waste disposal costs.

Figure 5. Brine sludge waste
(Credit: Fuhua Tongda Chemical Co., Ltd.)

3. Conclusions

Fuhua Chemical's practices show that optimizing production processes, extending industrial chains, and building resource recycling networks are effective pathways for chemical enterprises to achieve green and low-carbon transformation.

· Focusing on key elements such as phosphorus, chlorine, and sodium through systematic and circular design not only helps to identify resource circulation potential within the value chain, but also promotes the high-value utilization of by-products through technological innovation, thereby achieving the fundamental transformation of "turning waste into resource."

· Building cross-enterprise resource recycling networks and extending industrial value chains can optimize regional resource utilization efficiency while fostering collaborative pollution reduction and carbon mitigation across enterprises.

· Coordinating water, energy, and carbon management in an integrated manner enables the creation of synergistic approaches among key factors, providing a new pathway to drive high-quality economic development through circular practices.

Case provided by CCICED Special Policy Study on Promote High-Quality Development with Circular Economy