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After six years of joint development efforts between LIST and TITK, the first two continuously operating, pilot plants with LIST Lyocell Dissolving systems were installed in Europe and in Asia. Initial start-ups, each plant has operated successfully with on-going process optimization and continued efforts to increase both process and operational knowledge with the focus on commercialization of the process technology.

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Current Situation of Development

Single Step Cellulose Dissolving

In contrast to the huge market for economical man-made fibers, there are some applications in special, small demand, niche applications for films, filaments, and fibers. For these applications a multi-step process is not economically feasible. Consequently, LIST and TITK developed, and patented, a single-step dissolving technology.

Throughout the process development, both TITK and LIST gained tremendous knowledge of the physical cellulose dissolving process. With annual capacities below 1000 metric tons per year, the LIST single-step dissolver can be applied for an efficient and economical process solution.

A New Generation of LIST Dissolver

Beginning with the LIST DISCOTHERM B CONTI as a base equipment platform, the LIST Lyocell Dissolver has not only improved, several generations of LIST Dissolvers in operation today. Each generation has improved the process efficiency and performance. The last generation is being currently fabricated.

Increasing Capacity per Line

The current design maximizes the operating capacity per line and guarantees the highest economy and lowest costs per kg fiber. Today the LIST Cellulose Dissolving System is able to produce up to 10'000 t fiber/year and line. The production capacity is dependent on the cellulose content in the spinning solution and the composition of the used solvent.

Specialized Auxiliaries

The thixotropic nature of the cellulose pre-mix and the operation of the LIST dissolver under vacuum, demanded for the specialized auxiliaries. LIST designed a specialized feed system able to continuously feed the pre-mixed cellulose from atmospheric environment into vacuum. Furthermore, LIST optimized the process of discharging the cellulose dope from the Dissolver combining degassing of the product, pressure build-up for material transport, and discharge from vacuum into the dissolver tank. The new design of the unit is able to separate the removed parts of the complete LIST process solution.

Simulating the Dissolving Process for scale up

LIST possesses process simulation routines for the design of the complete range of plants starting from the pilot scale. The results are the required equipment sizes, the energy hold-up and the investment estimates. These process models are invaluable tools for the on-line process simulation and for evaluating the impact of process variables on the operation of the units. As the market demand for Lyocell fibers increases, efficient and safe manufacturing processes must be in place to meet the production requirements. LIST has many years of experience in the design of cellulose pre-mixing and dissolving equipment and continues to develop and optimize its technology in this field.

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As world consumption of textile fibers expands with the rapid growth of Asia and other developing countries, sources like cotton and rayon must be developed and brought to market to meet demand. Cellulose fibers (Lyocell fibers) can meet these expanding needs because of the specific qualities and characteristics of the fiber, as well as the vast availability of the raw materials.

While process efficiency and flexibility is important in every industrial manufacturing process, operational safety is tantamount to its successful integration into the manufacturing environment. The LIST Lyocell Dissolving process takes this into account and has been designed to address the particular safety concerns surrounding the use of NMNO as a solvent with its associated extremely low vapor concentration danger. The LIST system includes highly sensitive temperature and energy input control systems and an automatic emergency process shutdown for a system that puts safety first.

NMNO will begin to decompose at elevated temperatures. The initial low temperature decomposition reaction is dependent on the impurities present. With a recycle rate of up to 99%, these impurities are eventually accumulated and impurities reduce the decomposition temperature creating an unsafe operating condition. Special studies conducted at a temperature of 130°C showed a rapid increase of pressure to greater than 100 bar pressure as the NMNO decomposed.

Safety Philosophy

Today, stabilizers are used to increase the temperature at which NMNO decomposes, but the reaction cannot be completely mitigated and must be addressed. The LIST system operates at temperatures less than 100°C to ensure that the heating media and the product maintain a large enough temperature difference to the dissolving zone to prevent the temperature of NMNO. The Dissolver is also outfitted with many temperature sensors that constantly monitor process temperature for safe and stable operation.

LIST – Automatically shut down system

Regardless of the extent of process control, it is always possible that an upset condition could drive the process temperatures into the range where the NMNO decomposition reaction will begin. To address this possibility the LIST Lyocell Dissolving system has an integrated water flooding system. The rapid introduction of water into the process chamber breaks the vacuum and absorbs a tremendous amount of heat thus quickly lowering the product temperature and preventing the further decomposition of NMNO. Because the LIST equipment is oriented horizontally with a fill level of approximately 50%, the water will disperse itself along the entire length of the unit thus preventing hot spots.

Summary

LIST AG has developed a viable process for the production of high quality fibers, films, filaments, and special technical textiles from different cellulose raw materials to the design of greater flexibility and an increased level of safe operation. As the demand for cellulose-based fibers grows, LIST continues to develop and expand its technology to meet this demand.

LIST AG continues to develop and optimize this technology focusing on increasing capacity and the use of cheaper, more abundant, cellulose raw materials.

Fig. 1 – LYOCELL Process

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