Innovative solutions for obtaining and processing high quality proteins

Proteins are playing an increasingly important role in human and animal nutrition – adding more proteins while removing fats and carbohydrates from the daily diet is now recommended by an ever-growing number of nutritionists.

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Mixing containers or fermentation tanks for effective enzymatic hydrolysation of proteins.

Proteins have long been used effectively in sports and clinical nutrition as well as in dietary supplements. Additionally, proteins are frequently used within the agricultural and industrial sectors – as fertilisers, lubricants or cleaning agents – and in many other applications.

Proteins are essential elements of all forms of life. In the human body, proteins perform a whole range of vital functions and act as energy suppliers alongside carbohydrates and fats. From a chemical point of view, dietary proteins consist of long amino acid chains.

Alongside the proteins that are extracted from plant-based raw materials, proteins from animals play an important role too. Thanks to the innovative processing technologies, it has become possible to obtain proteins for different purposes and from various sources in an efficient and sustainable way.

With the right expertise and equipment, the maximum amount of protein can be extracted from the raw material, a high purity output can be secured, and resources can be saved at the same time.

A sterilisation plant for preserving food products.

Innovative process solutions

In order to extract high quality proteins, innovative process solutions are required. Not only might proteins of different origins have significantly different features, but the attributes of the protein end products may have to meet very individual demands.

As an expert in the processing of liquid products, Ruland Engineering & Consulting develops tailored plant components and solutions for protein extraction, processing and refining.

The primary objective of every protein manufacturer or processor should be to utilise all available raw material exhaustively and to yield the maximum outcome. Another essential requirement when extracting and refining proteins is optimal resource allocation so that fresh water and electricity usage are kept as low as possible and wastewater output is minimised.

Preliminary processing: clearing turbidity

The first step in protein processing involves the separation and purification of distinct components from a liquid mixture consisting of fats, water and proteins.

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Using decanters and separators, coarse solids and fats are removed – the latter often ultimately being used in the animal feed industry.

After passing through a centrifuge, turbid elements and residual fats are separated from the protein mixture. Particular expertise is required here, in view of the length of the amino acid chains and process parameters such as temperature or pH.

The equipment has to be perfectly in tune with the products and the parameters. The quality of the outcome is highly dependent on the use of membranes with appropriate pore diameters and suitable filters.

For long-chain proteins, in most cases, conventional filters are used because the proteins are too long to pass through fine-pored membranes, which would become clogged.

In contrast, fine-pored membrane technology is ideal for short-chain and hydrolysed proteins, and it helps to remove the remaining turbid elements from the protein mixture. In fact, this method produces significantly better results in terms of turbidity (NTU-Value) than standard filters. This preliminary cleaning is one of the most important steps in the whole process because it determines the quality of the final output.

After it has been cleaned, the solution is desalinated and concentrated. Depending on the protein source, membrane technology will once again be used, in many cases combined with an evaporation system.

A filtration system purifies proteins for further use.

Effective desalination with diafiltration

Partial desalination is required for some products and grades. For this purpose, specialist ion exchangers and membranes are used.

Ultrafiltration and nanofiltration membranes remove mono- and polyvalent salts as well as bitter compounds and other flavours and odourants. An additional diafiltration stage can wash even more salt out of the product.

Diafiltration technology combines the features of both dialysis and ultrafiltration. During this process, a solvent is continuously added to the pre-concentrated protein solution until the old solvent has been completely replaced via the membrane. The volume of the suspension remains unchanged.

Optimal concentrating and drying

Depending on the pretreatment methods used, the main process is carried out in either one or two steps. If the proteins are highly hydrolysed and of a short chain length, the solution can be concentrated using membranes up to the required level and then spray dried. For long-chain proteins, the final concentration can be reached by means of an additional evaporation stage.

The combination of membranes and evaporation equipment for the processing of long-chain proteins offers the advantage of allowing the processor to choose the optimal transition point.

Not only does it relieve the membranes, but it also allows a single or multi-stage evaporation plant to be downsized. This

results in optimal allocation of resources at the same time as providing the best quality output.

Controlled fractionation for defined chain length

In order to obtain a protein hydrolysate with a clearly defined range of chain lengths, protein fragments need to be separated according to their molecular size.

A multi-stage filtering process involves initial filtering of large, long-chained particles through an open membrane, followed by the separation of short-chained proteins via membranes with narrow pores. Thus, different chain lengths for various application fields can be obtained.

Saving resources – water treatment

Processing proteins is extremely water-intensive. Therefore, effective water treatment or the early reduction of its use are particularly important.

Drinking water first needs to be softened in a complex process. After use in processing, water can be partly recycled using suitable treatment technology in order to lower the amount of organically polluted wastewater that reaches the sewage system.

To achieve this, water streams are joined, mixed and subsequently treated with filtering and membrane equipment.

Today, up to 80% of the water used during protein processing can be recycled.

Efficient cleaning for higher yield

Since cleaning is a matter of high priority, Ruland's experts are dedicated to reviewing and optimising the cleaning systems at all production sites.

Cleaning-in-Place (CIP) plants are deployed whenever pipelines and tanks need to be cleaned.

Depending on the level of production output, either central CIP plants with multiple tanks and chambers or local mobile CIP plants are installed.

It is also possible to extend the system with a Sanitary-in-Place (SIP) process when cleaning has to be followed by sterilisation.

Maximum yield, minimum product loss

Alternatively or in addition to classic pigging technology, whirlwind technology can be deployed in order to minimise product loss and maximise yield. Draining a pipeline using whirlwind technology comprises two steps. The power of a turbulent air flow is used to remove product residues from the pipelines efficiently. Extended by a basic module, this technology can also take care of chemical cleaning and rinsing. It requires a minimum amount of water and cleaning agents and is especially suitable when fast product switches with minimal product losses are required.

Practical, safe and efficient

Whatever technology or process is used, it has to be practical, safe and efficient. Sustainability plays an important role here too. Production plants and technologies have to be high performance, durable and able to deliver consistent high quality; additionally, they need to meet the current demand for conserving resources and reducing rejects.

Whether it is a centrifuge, a decanter, membrane technology or a cleaning agent, all components need to complement each other perfectly to ensure smooth and reliable performance. Protein processing can be very diverse, so tailored solutions are usually superior to standard processes and plants.

As an expert in liquid processing, Ruland Engineering & Consulting has extensive expertise, and its team always works closely with its clients in order to find the best possible solutions in all cases. ■