Distillation technology for the 21st century

Modern industry requires more and more very pure chemicals. Therefore separation technologies become correspondingly important, complex and expensive. The most common separation technology is distillation.

Modern industrial distillation was established some 40 to 50 years ago. Distillation consumes huge amounts of energy and it can incur more than 50% of a plant operating cost. Significant efforts by thousands of researchers and developers around the world during the second half of the twentieth century did not bring sufficient improvement in industrial distillation. Main efforts were concentrated on local improvements and the main principles of modern distillation were not changed for a considerable time.

In general, distillation is a very conservative process. Huge rectification towers at chemical and petrochemical plants are a symbol of modern industry. The height of rectification towers exceeds 50 to 60 m. Costs of design, manufacturing, transport, operation and repairs become enormous. Rectification towers looks like dinosaurs and clash with the technological image of the 21st century.

Core fundamental problems

Modern industrial distillation is based on tray and packed columns. Careful analysis of heat and mass exchange processes inside the columns shows many anomalies such as:

1. Modern design of rectification columns does not pay attention to real microbalance of heat and mass exchange processes.
2. Mass and heat exchange processes in every point of conventional columns are not correlated to each other because of differences in physical properties of low and high boiling point compounds.
3. Modern arrangement of composition and amount of reflux do not correlate to real distribution of low and high boiling compounds along rectification towers.

This results in columns being very tall and requires more energy for the distillation process leading to a high cost of operation.

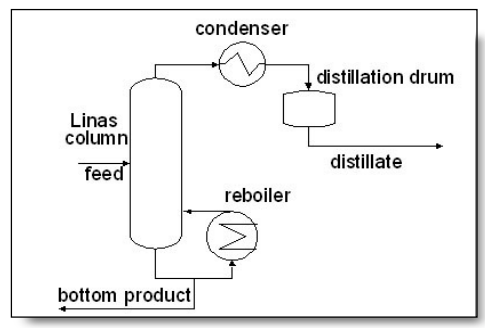
Linas distillation technology

A small group of enthusiastic and highly professional researchers and engineers started a company known as Linas-Tekhno Inc. They have developed a totally new solution for industrial distillation and have developed a new industrial distillation technology called Linas technology based on a modified film distillation.

Indeed, a conventional film distillation has several attractive advantages such as simple construction, very low flow resistance and good separation ability. Film distillation has the lowest height of theoretical tray (= 5 mm) among all distillation technologies, but only if vapour velocity is around 1 cm/s. Therefore, applications of the film distillation are very limited. At high vapour velocity along vertical surfaces, a film ceases to be uniform and heat and mass exchange process becomes unstable and all the advantages of film rectification are not realised.

This main problem of a conventional film distillation was solved by Linas technology. Industrial applications of Linas technology gives:

1. A stable distillation film under a velocity of a vapour stream inside of Linas' column up to 1.5-2.0 m/s.
2. Adaptation of heat and mass exchange processes inside the Linas column to the physical properties of separated compounds.
3. New arrangement of the reflux process. All evaporated distillate is a final product according to the scheme below. Linas reflux process takes place inside the Linas distillation towers.



4. Three to ten fold reduction of the height of rectification towers and 50 to 100 times reduction in the amount of separated compounds inside the Linas column compared with conventional rectification towers.

Industrial applications of Linas technology

The first industrial application of Linas technology was accomplished three years ago for distillation of fluorine-organic compound at the Angarsk chemical plant. The height of the column is only 1.4 metres. After three years of continuous operation the rectification column did not demonstrate any real distillation problems. Recently Linas-Tekhno Inc. designed and manufactured the first industrial oil refinery based on the Linas distillation technology. The oil refinery SMR-10 (10.000 MT/Y of crude oil) is in operation in the city of Miass, Russia for eight months. Certified gasoline, diesel oil and black oil were produced by the oil refinery. The height of the rectification tower is 1.5 m. In operation, the rectification tower contains 1.5 kg of materials only. Industrial operation of the SMR-10 confirms the advantages of the new technology. Total energy savings are about 10% and operating costs were reduced at least 50%.

The Linas rectification tower is controlled by automatic processes. The new rectification towers are simple and reliable and do not require a complex automatic system.

A general view of SMR-10 is presented in picture figure 2.

The rectification tower is so small that it is not even visible in the picture.

Figure 2

Technical data of the oil refinery SMR-10 (Linas-Tekhno) based on Linas technology and a conventional oil refinery is presented in the following table.

Type of plant	SMR-10	Conventional
Capacity	10000 MTY	7000 MTY
Type of feed	Crude oil	Crude oil
Yield of useful products	>99.9 % wt.	>99.9 % wt.
Pressure	0.11 mP_	0.17 mP_
Weight of unit	4.2 t (column + furnace + evaporator)	5.6 t (column only)
Height of column	1.5 m	10 m
Diameter of column	500 mm	520 mm
Consumption of furnace	13-24 kg/h	12.6-22 kg/h
Electric power	8 kW	27 kW
Operating conditions	-55C - (+55C)	-30C - (+55)
Type of operation	Continuous	Continuous

Indeed the technical parameters of Linas rectification tower are superior to a conventional rectification tower.

Linas-Tekhno is developing several industrial distillation processes based on Linas technology:

1. An industrial distillation process for waste lube oil regeneration with a 1.5 m height column.
2. A distillation of benzene produced from coke. Rectification unit for a capacity 18,000 MTY contains two rectification towers with heights 3 and 4.5 m and diameters 0.9 and 1.3 m respectively. A conventional distillation unit contains two columns with heights 26 and 32 m and diameters of 1 and 1.5 m.
3. Production of high quality $SiCl_2$. Content of main product is 99.9999 wt. %. Height of the rectification tower is only 2.5 m.
4. Distillation of ethanol-water mixture on a column with a height of only 4.5 m. Linas distillation process saves around 15 % energy compared to a conventional distillation process.

Advantages of Linas technology

Real industrial operation of rectification towers based on the Linas technology confirms several advantages of the technology such as:

1. Heights of rectification towers were reduced 3-10 times compared to heights of conventional tray and packed columns.
2. Amount of separated compounds inside the columns is reduced 50-100 times compared to conventional rectification towers.
3. The residence time of the rectification process is between 2 and 60 seconds only.
4. Total reduction of energy consumption is around 10 %.
5. It is possible to separate thermo-unstable compounds.
6. Operation, cleaning and repair costs are at least 50% less than for conventional columns.
7. Linas rectification towers have a higher resistance against earthquakes.
8. Dramatic reduction of manufacturing, transport and assembly costs.
9. Totally simple scale up process. For example the design of Linas columns for crude oil refineries with a capacity from 86 to 500,000 MTY is presented in figure 3. D is a diameter of columns, H is the height

Figure 3

of columns.

The basic element of the columns is a single Linas distillation tube and the capacity of the columns can be increased by increasing the number of tubes. Indeed, there is no difference in parameters of distillation processes between one tube with a capacity 86 MTY and 6250 tubes with a capacity 500,000 MTY. It means that the design of any industrial unit can be carried out very rapidly if there is data for one distillation tube.

A conventional scale up process is very complex and does not give any warranty for a successful result. Increasing the capacity always result in a larger diameters and height of columns.

All advantages, taken together, mean a real breakthrough in industrial distillation.

Future of Linas technology

Linas technology has one further advantage. The technology saves money for every step in a long chain of industrial distillation from designers to users of rectification towers as presented below (data are compared to conventional technology):

1. Design - 2-3 times less cost
2. Scale up process - 3-5 times less cost
3. Manufacturing - 1.5-2 times less cost
4. Transport and assembly - 2-5 times less cost
5. Operation, repair and service are at least 50 % less.
6. Energy saving is around 10 %.

Linas technology will change the landscape of the chemical, petrochemical and oil refining process. Huge conventional rectification towers will be replaced by compact Linas columns. It will take several years. The industry is relatively conservative but money is the best motivation for action.. Linas technology is cheaper and better than conventional distillation technology. The global market always accepts better and cheaper technologies. **HA**

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