TTC Labs, Inc.

Process Engineering Excellence

BTX Extraction Technology

TTC specializes in low energy consumption and high capacity applications in BTX extraction units. Rigorous thermodynamic and hydraulic calculations optimize parameters and used to rate the equipment. All commercially available solvents are covered. TTC technology is covered with US and other patents.

Solvent Selection

The selection of the solvent is often based on some fundamental property such as solvency and selectivity. As can be seen in the Figure 1, the more polar solvents have the highest solvency at a given selectivity.

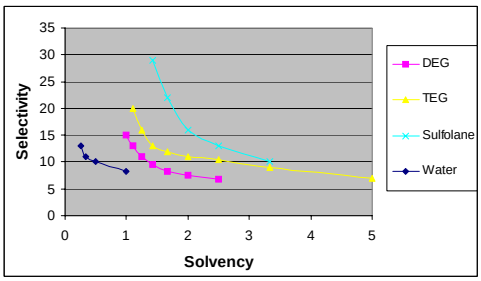

Figure 1. Solvency vs. Selectivity

A solvent with high solvency would require a lower solvent circulation rate and therefore require a lower capital budget. However, this is true only for the extractor and extractive distillation columns. Because the solvents with high solvency are difficult to remove from the products, they require additional equipment. The polarity of a molecule can be demonstrated by its shape, as shown in Figure 2.

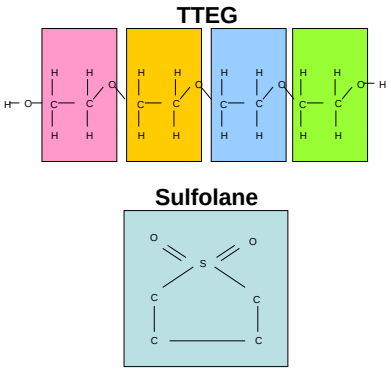

Figure 2. TTEG and sulfolane molecules.

As it turns out, each solvent has its own advantages. For example, the advantages of more polar solvents such as sulfolane are:

- High solvency and selectivity
- Smaller extractor and extractive distillation column
- Slightly better xylene recovery

In contrast, the advantages of less polar solvents such as the heavy glycols are:

- Less corrosion
- Easier to heat integrate with low pressure steam
- Easier to remove from products
- Lower capital costs
- Less expensive and more readily available solvent
- Purchase on free market

For quality, TTC technology can make CH-Grade benzene and TDI-Grade toluene with any of the commercially available solvents.

PROCESS DESCRIPTION

The purpose of a BTX extraction unit is to produce high purity aromatics from a feed stream of aromatic and non-aromatic components. For most BTX extraction units, the recovery of aromatics occurs in a liquid-liquid extractor column while the purification takes place in an extractive distillation column. Steam stripping is used to remove the aromatics from the solvent.

For the more polar solvents, additional equipment is required to remove the solvent from the products. For example, sulfolane solvent requires a refluxed recovery column and a counter-current water wash column just to recover the solvent.

There are some opportunities when just extractive distillation without a liquid-liquid extractor is a better flow scheme. Examples include feeds with narrow distillation ranges (small carbon number range in the feed) and certain other combinations. However, this process flow scheme often requires more than one reflux stream even for the less polar solvents, and therefore has a higher energy consumption.

Figures 3 and 4 show typical flow schemes for the different solvents.

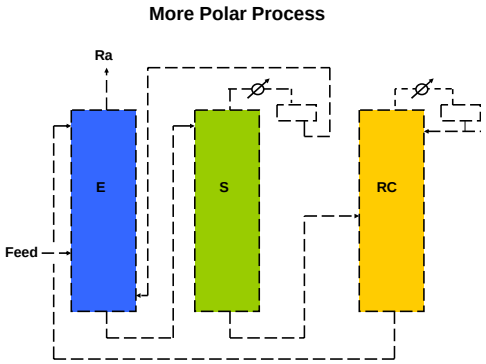

Figure 3. More polar solvent flow scheme.

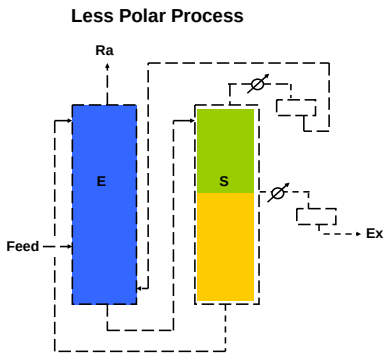

Figure 4. Less polar solvent flow scheme.

For each flow scheme, there is the one internal “reflux” stream from the top of the stripper to the extractor. Because this reflux stream purifies the extract in two different columns, this flow scheme has a built-in advantage for energy consumption.

Product Purity and Yields

TTC technology can produce CH grade benzene and TDI grade toluene. Typical recovery of benzene, toluene and xylenes is at least 99%, 97% and 91%, respectively. Higher recoveries require slightly more energy.

Energy Consumption

Based on BTX reformate with 65% aromatics and making high purity BTX extract, most of the commercially available solvents including dmp, sulfolane and the heavy glycols require about 600 Btu per pound of extract. With an optimized flow scheme utilizing TTC technology, the value of energy consumption can be reduced even further. In any case, all of the solvents require about the same amount of energy.

The second energy cost issue on solvent selection is the quality of the heat required. For the less polar solvents, where enough water is present in the lean solvent to have an important effect on the boiling point, the temperatures in the reboilers are low enough to use low pressure steam or a vapor stream from certain fractionators.

Heat Integration

Because the cost of energy continues to rise, heat integration is giving many BTX extraction units a competitive edge. As mentioned above, the choice of solvent will determine the ease with which a unit can be heat integrated. Because glycol solvents can operate at lower temperatures, they are easier to heat integrate.

For example, solvents such as the heavy glycols can utilize heat from the overhead vapor streams of a xylene column, high pressure toluene column or 50 psig steam. Often, this makes the cost of energy for the extraction section almost free. Figure 5 shows a modern heat integration scheme.

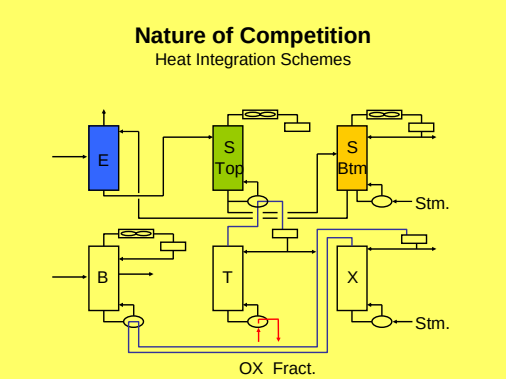

Figure 5. Possible heat integration schemes.

ISBL Cost Estimate

The following table shows the ISBL costs assuming 10,000 BPD of reformate feed producing high purity aromatic products.

Technology	Cost
Udex	USD 7.5 million
Sulfolane	USD 10 million
Extractive Distillation	USD 8.5 million

TTC Labs, Inc.

Process Engineering Excellence

Industrial Experience

The following table shows the number and types of units for which TTC has completed projects in the last year. These numbers include both domestic and international customers.

Type of Unit	Number in Last Year
Aromatics Revamp	17
Grass Roots Design	3
Profitability Study	3
Benchmarking Study	6
Schools	5

Domestically, TTC has had the honor to work in refineries owned by ExxonMobil, Citgo, ChevronPhillips, LCR, Equistar, Valero, Williams, Flint Hills and Frontier. Internationally, TTC has completed projects in Japan, Germany, France, Spain, Canada, Romania, Poland, India, Qatar, Singapore, Brazil, and Argentina.

The aromatics revamps usually include a decrease in energy and/or an increase in capacity. The grass roots designs cover the complete process specifications for a new unit. Profitability studies typically examine the feasibility of and modifications required for increasing capacity, while a benchmarking study analyzes how a unit is currently operating compared to top tier competitors.

The TTC Extraction School is a 6-hour technical class detailing all aspects of BTX extraction, including an in-depth discussion of each piece of equipment, the effects of changes on the income statement and the causes and solutions to corrosion. In addition, the TTC schools cater to the issues specific to each customer's plant and provide the opportunity for the class participants to create a work list.

Typical TTC Benefits

With TTC technology, most customers experience the following benefits:

- 20-30% increased capacity
- 10-50% decreased energy
- More robust operations
- Fewer problems with corrosion
- Inexpensive advanced control
- Utilization of existing equipment as much as possible
- Become cash neutral within 3 to 6 months

For More Information

TTC
280 E. Harborview Dr.
Fond du Lac, WI 54935
(920) 923-9754
www.ttclabs.com