SOLVENT EXTRACTION

Unlock Potential, Create Value
Tenova Advanced Technologies (TAT) offers differentiated, project-specific process technologies based on decades of research, equipment design and project execution. Advanced solutions include solvent extraction (SX) and electrowinning (EW) for the mining and chemical industries, membrane circuits, in-house state-of-the-art R&D facilities, expertise in minerals beneficiation as well as phosphate processing from ore to purified phosphoric acid and salts.

Tenova Advanced Technologies specializes in both innovative technology development and robust process equipment for solvent extraction.

Their experience and expertise in all aspects of SX includes:

- Development of SX processes utilizing an in-house R&D center
- Detailed design, supply and construction of SX plants based on:
  - TENOVA SETTLER™ (Proprietary Reverse Flow Mixer Settler)
  - Tenova Pulsed Column (TPC)
  - Tenova Turbulent Technologies (TT) Mixing System

Copper SX/EW Plant, Chile
**TENOVA SETTLER™**
The TENOVA SETTLER™ is a patented technology which enhances efficiency and provides many advantages compared to conventional settlers used in traditional SX circuits.

- High process efficiency with low organic loss
- Compact layout
- Short construction time
- Low capital cost
- Ease of operation and maintenance

Tenova Advanced Technologies' experience with designing, installing and commissioning SX plants using the TENOVA SETTLER™, enables it to supply the SX section of an SX plant on a LSTK basis providing the client with full process and mechanical guarantees.

Advantages of the TENOVA SETTLER™ compared to similar designs:

- Approximately a 20% lower in capital cost for the SX plant
- Increased flux rate capability which can further reduce costs
- Decreased organic losses
- Operator friendly physical layout
- Total automatic control capability
- Improved fire prevention and control features

**TENOVA PULSED COLUMNS**
The Tenova Pulsed Column is a high efficiency cost-effective contactor which enhances SX during extraction, stripping and scrubbing or washing processes.

**Advantages of the Tenova Pulsed Columns**

- The extraction is a multi-stage continuous process
- The system can handle liquids with suspended solids or which form third phases
- Safe and environmentally friendly process
- The columns have no internal moving parts
- A fully automated system
- Low maintenance and operating costs
- Dramatically reduces floor space required
- Head space can be inerted, virtually eliminating solvent loss and fire risk

**Applications of Tenova Pulsed Columns**

- Virtually all industrial SX processes can be enhanced using Tenova Pulsed Columns, particularly those with a fast rate of mass transfer. Applications include:
  - Minerals processing: uranium, nickel, cobalt, zinc, titanium
  - Chemical industry: nitric, phosphoric and hydrochloric acid
  - Environmental protection: recovery of nitrates, sulfuric acid, cyanides, and halides
  - Additional applications such as pharmaceutical, food and petroleum industries

**THE TENOVA TURBULENT TECHNOLOGIES MIXING SYSTEM**
Tenova Turbulent Technologies Mixing System is a new mixing technology which enables significant reduction of entrainment levels without changing the process flow. It can easily be retro-fitted to most existing mixer settlers or installed in new SX plants.

**Unique capabilities:**

- Creates uniform dispersion in the mixing tank (avoiding formation of small droplets)
- Predictable and controlled drop size distribution as a function of the mixing regime, allowing process optimization

**Advantages:**

- Reduces entrainment of expensive extractants
- Reduces organic contamination in the product stream
- Reduces ecological impact of organics in the raffinate stream
- Enables increase of settling flux (flow per unit settler area) while maintaining same level of entrainment
- Reduces maintenance costs
- Eliminates the need for after-settlers
LUMP-SUM TURNKEY AND DESIGN & SUPPLY SOLUTIONS

Tenova Advanced Technologies is one of the few companies able to offer pulsed column and mixer settler design and installation as a complete package, with process and mechanical guarantees. Accurate cost estimates are generated during feasibility studies, based on proven scale-up factors from pilot scale test work.

The SX R&D team offers comprehensive process and equipment development, supported by a complete suite of facilities and laboratories for in-house bench-scale and pilot testing of SX circuits and state-of-the-art analytical services. Our extensive collaborative network covers research institutions and test work laboratories in Australia, Canada and South Africa.

Tenova Advanced Technologies has implemented SX projects across a range of commodities, many of which moved from laboratory test work, bench and mini-pilot plant testing, through to pilot and demonstration plants, and implementation of full scale industrial plants.

- Minerals and metals industry - processing uranium, copper, nickel, cobalt, gold, zinc, rare earth elements and vanadium
- Chemical industry - processing nitric, phosphoric, hydrochloric and citric acids, inorganic salts and organic solvents
- Specialized SX processes for the mineral industry including sulfuric acid, halides and cyanide removal
- Bio-based Chemical industry - downstream separation of bio-based products and bio-fuels
- Environmental protection - effluent treatment, removal of nitrates and heavy metals
- Petrochemical industry - processing lubricant oils and caprolactam

SX PROJECT DEVELOPMENT

Over the years Tenova Advanced Technologies has cultivated a comprehensive step-by-step approach for project development, ensuring the all-around fulfillment of the project requirements and the successful delivery of the project.

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PROCESS GUARANTEE & MECHANICAL WARRANTY
SELECTED PROJECTS

- **ANTOFAGASTA MINERALS, Antucoya, Chile**
  Design, Supply and Construction of an 80,000 tpa copper SX-EW plant

- **BAJA MINING, Boleo, Mexico**
  Design of a 60,000 tpa Copper SX-EW plant consisting of 4 SX circuits and 2 EW facilities

- **KAZAKHMYS, North Nurkazgan, Kazakhstan**
  Design and supply of a 3,000 tpa copper SX plant

- **VALE INCO, Long Harbour, Canada**
  Design and supply of Nickel/Cobalt/Copper SX plant

- **ANGLOGOLD ASHANTI,**
  SUP SX Replacement, South Africa
  Design and supply of a uranium SX plant

- **VALE, Goro, New Caledonia**
  Design and supply of two SX plants for Ni & Co

- **CODELCO, Gaby, Chile**
  Design, Supply and Construction of a 150,000 tpa copper SX-EW plant

- **BHP BILLITON, Olympic Dam, South Australia**
  Design, Supply & Construction of a Uranium SX plant

- **VALE, Tres Valles, Chile**
  Design, Supply and Construction of a 22,000 tpa copper SX-EW plant

- **Copper SX/EW plant, Chile**
- **Nickel SX plant, New Caledonia**
- **Copper SX/EW plant, Zimbabwe**
- **Uranium SX plant, Australia**
- **PPA SX plant, China**
- **Copper SX plant, Chile**