

# HEAT EXCHANGER APPLICATIONS

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SEAMLESS STAINLESS STEEL AND  
HIGH NICKEL ALLOY TUBES

# Tubacex Group: a global technological partner in heat exchanger

The Tubacex Group has become one of the world's main seamless stainless steel and nickel alloy tubular solutions providers.

Founded in 1963, Tubacex brings the experience of a world leader combined with a strong R&D effort which is needed to fulfill the future needs of the industry.

The Tubacex Group, exporting into more than 100 countries worldwide, has a share of around 15% of the world market of seamless stainless steel

tubular solutions, with a total workforce of around 2.400 employees. The headquarters are located in Llodio, 25 Km (15 miles) from the seaport city of Bilbao, in northern Spain.

The Tubacex Group's integrated production process includes a steel making plant, several extrusion and cold finishing mills, trepanning facilities, fitting and special components producers and wide network of service centers which provide a wide range of added value operations to the group's portfolio.



## Worldwide presence

Through our commercial offices

## Competitiveness

Thanks to our lean manufacturing process

## Service

Cooperation with our customers

## Flexibility

In materials chemical composition & deliveries

## Reliability

Of a fully integrated company

**Commitment** for high technological value products

Continuous innovation during the last 30 years has allowed the Companies of the Tubacex Group to become world leaders in the supply of seamless tubes made of stainless steel and nickel alloys. Tubacex Group's heat exchanger tube program is based on manufacturing units at these 4 strategic locations:

Llodio & Amurrio, Spain

**TTI**

**TUBACEX**  
GROUP

**Founded in 1963, TTI has become the world's main supplier of stainless steel seamless tubes and pipes. Seamless Stainless Steel and Nickel Alloy tubes and pipes**

The size manufactured through the extrusion press and the 11 cold rolling machines, goes from ½" up to 8" NPS, or 19 - 250 mm OD, at manufacturing facilities located in Llodio and Amurrio (Spain). A specific line is fully devoted to OCTG (Oil Country Tubular Goods) manufacturing, in a range that goes to 9 5/8" (currently in trial).

Ternitz, Austria

**SCHOELLER  
BLECKMANN**

**TUBACEX**  
GROUP

**Schoeller-Bleckmann's roots date back to 1924.**

**Seamless Stainless Steel pipes and tubes**

Schoeller Bleckmann Edelstahlrohr, located in Ternitz, Austria, manufactures Seamless Stainless Steel in dimensions between 1/8" and 8" NPS, or 6 - 250 mm OD.

A specific plant is devoted to special tube manufacturing, with focus in straight and welded tubes for umbilical application and other high demanding applications (Nuclear, Fertilizer).

Greenville (PA), USA

**SALEM TUBE**

**TUBACEX**  
GROUP

**Salem Tube has maintained a reputation as a premier supplier for more than 40 years.**

**Welded re drawn and Seamless Stainless Steel and Nickel Alloy tubes**

Located in Greenville, PA (USA) Salem Tube's manufacturing range goes from 1/8" to 2" OD.

The company is highly specialized in precision tubing for the most demanding industries such as military and aerospace, with a heavy concentration of high nickel alloy grades in their product portfolio.

Umbergaon, India

**TUBACEX  
INDIA**

**TUBACEX**  
GROUP

**New addition to the Tubacex group, TUBACEX India has its production up and running under new management. Seamless Stainless Steel tubes and pipes**

Located in Umbergaon (Gujarat- India), Tubacex India manufactures cold finished tubes and pipes from 6 mm OD to 273.1 mm OD.

The company is able to deliver tubes up to 14 m (length), straight and U-Shape, to a wide range of customers. The company is ISO 9000 and ISO 14000 certified.

## MANUFACTURING RANGE HEAT EXCHANGER TUBES

Tubacex can manufacture and supply heat exchanger tubing in sizes ranging from 12 mm to 76 mm OD. All standard outside diameter and wall thickness for heat exchanger tubing are covered with maximum lengths of 30 meters. Tubes can be supplied in straight or U Bends. Special sizes can be made on request.



## PRODUCTION FOOTPRINT

The Tubacex Group offers extensive equipment as extrusion presses, pilger machines, straightening machines, degreasing facilities, solution & bright annealing furnaces, stabilization furnaces and drawing equipment:

TUBACEX GROUP COMPANY	SIZE	LENGTH	STANDARDS	TESTING	APPROVALS
Salem	15 mm OD to 58 mm OD. WT 0.8 mm to 3.4 mm.	Max developed length of 22 meters	ASTM/ASME/EN/ DIN	In house: NDT (Eddy current testing, Ultra sonic testing, Hydro testing), PMI, Mechanical (Tensile/Hardness/Flattening /Flaring/Bend), Chemical analysis, Corrosion -Inter granular corrosion, ASTM G48, ASTM A923.	AS 9100, ISO 9001, ISO 14001, NCA-3800, PED 97/23/EC, Nadcap - Heat Treating, Nadcap - Material Testing, NORSOK M650 (31803, 32750 & 31254)
Schoeller Bleckmann Edelstahlrohr	12 mm OD to 88.9 mm OD. WT 0.8 mm to 4.4 mm.	Max developed length of 37 meters	ASTM/ASME/EN/ DIN/GOST/AFNOR	In house: NDT (Eddy current testing, Ultra sonic testing, Hydro testing), Mechanical (Tensile/Hardness/Flattening /Flaring/Bend), Chemical analysis, Corrosion -Inter granular corrosion, ASTM G48 Mthod A, ASTM A923.	ISO 9001, ISO 14001, OHSAS-18001, PED 97/23/EC, TUV Shop approval, NORSOK M650 (31803, 32205, 32750, 32760, 31254)
Tubacex India	12 mm OD to 88.9 mm OD. WT 0.6 mm to 6 mm.	Max developed length of 14 meters	ASTM/ASME/EN	In house: NDT (Eddy current testing, Hydro testing), Mechanical (Tensile/ Hardness/Flattening /Flaring/Bend), Chemical analysis, Corrosion -Inter granular corrosion, PMI.	ISO 9001-2008, ISO 14001-2004, OH-SAS-18001-2007. EIL, IBR, PED 97/EC/23, Norshok, DNV Marine.
TTI - Tubacex Tubos Inoxidables	19 mm OD to 88.9 mm OD. WT 1.65 mm to 4.4 mm.	Max developed length of 17 meters	ASTM/ASME/EN/ DIN	In house: NDT (Eddy current testing, Ultra sonic testing, Hydro testing), Mechanical (Tensile/Hardness/Flattening /Flaring/Bend), Chemical analysis, Corrosion -Inter granular corrosion, ASTM G48 Method A, ASTM A923.	ISO 9001, ISO 14001, OHSAS-18001, API 5LC, PED 97/23/EC, TUV Shop approval, NORSOK M650 (31803, 32750 & 31254).

## STANDARDS

The Manufacturing methods employed at Tubacex Group's main production units reflect the most advanced technologies. Production of seamless stainless steel tubes and pipes is carried out according to all common international delivery and tolerance standards.

- ASTM A 213- Standard specification for seamless, ferritic and austenitic alloy-steel boiler, super heater and heat exchanger tubes.
- ASTM A789- Standard specification for seamless, duplex stainless steel heat exchanger tubing.
- ASTM B161- Nickel seamless pipes and tubes.
- ASTM B163- specification for seamless nickel and nickel alloy condenser and heat exchanger tubing.
- ASTM B167-Nickel-Chromium-Iron alloys and Nickel-Chromium-Cobalt-Molybdenum alloy pipes and tubes.
- ASTM B668-standard specification for UNS08028 seamless pipes and tubes.
- EN 10216-5 TC-1 & TC 2, DIN Standards.





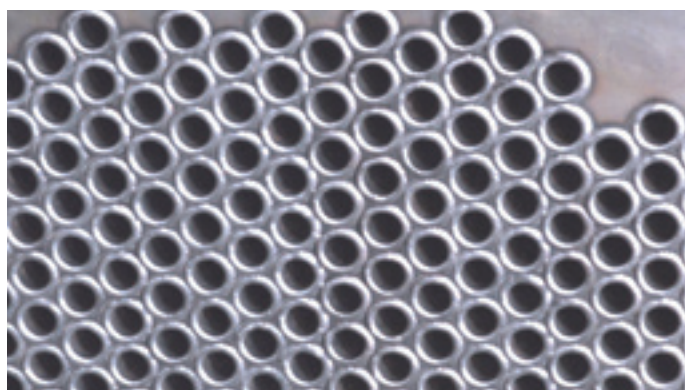
# Tubacex Group: A stainless steel portfolio suited to cover main

The need of higher efficiency in heat transfer processes and the need of improved characteristics against corrosion has increased the demand on the quality of the seamless stainless steel tubes used in these applications.

Depending on the industry and application, different corrosion issues require different materials. For each specific application, Tubacex offers a suitable solution through its stainless steel and high nickel alloy grade portfolio.



INDUSTRY	APPLICATION	CORROSION ISSUES	TUBACEX SOLUTION
Oil & Gas	Platforms	Heat Exchangers in Platforms- Chloride induced pitting and crevice corrosion. Heat exchangers in onshore facilities: Sour service conditions, Chloride induced pitting present in cooling waters.	TXD05 (Duplex) & TXD07 (Super Duplex) for chloride induced corrosion in Offshore platforms and TXK05 (Alloy28), TXK16 (Alloy625), TXK03 (Alloy825) for sour service conditions in onshore facilities.
Refinery	Hydrotreating units (REAC/FEAC).	Stress corrosion cracking, under deposit corrosion caused by Ammonia Bi Sulfide and Ammonia chlorides.	TXD05 (Duplex), TXD07 (Super Duplex), TXK03 (Alloy825).
	Crude Distillation units / Vacuum distillation units/ FCCU/Delayed cocker units	Corrosion issues in Over Head Condensers: Under deposits due to condensing vapours (acids & salts), Pitting corrosion caused by chlorides present in water cooling media.	TXD05 (Duplex), TXD07 (Super Duplex), TXK05 (Alloy28), TXK16 (Alloy625).
	Sour water strippers	Stress corrosion cracking, Pitting corrosion caused by Ammonia, chlorides, sulphides & cyanides.	TXD05 (Duplex), TXD07 (Super Duplex), TXK03 (Alloy825).
	Inter stage coolers	Pitting corrosion caused by chlorides present in water (cooling media).	TXD05 (Duplex), TXD07 (Super Duplex) & UNS32304.
	Amine coolers	Stress corrosion cracking, Pitting corrosion caused by Amines.	TUBACEX Solution: TXD05 (Duplex), TXD07 (Super Duplex), TXK03 (Alloy825).
	Napthenic acid	Pitting corrosion caused by napthenic acid.	TXC28 (317L) & TXC20 (316L with Min 2.5% Moly).
Petrochemicals	Amine coolers	Stress corrosion cracking, Pitting corrosion caused by Amines.	TXD05 (Duplex), TXD07 (Super Duplex), TXK03 (Alloy825).
	Napthenic acid	Pitting corrosion caused by napthenic acid.	TXC28 (317L) & TXC20 (316L with Min 2.5% Moly).
	EDC/VCM (Ethylene Dichloride / Vinyl chloro monomer)	Chloride stress corrosion cracking, pitting corrosion.	TXD05 (Duplex), TXD07 (Super Duplex).
	EG/EO (Ethylene glycol / ethylene oxide)	Scaling inside tubes, pitting corrosion caused by cooling water.	TXD05 (Duplex).
	PTA (Purified Terephthalic Acid)	Pitting corrosion in over head condensers caused by Bromides, Erosion corrosion in slurry heaters.	TXD05 (Duplex), TXD07 (Super Duplex), TXC28 (317L), TXK06 (904L).
	Methanol	Contamination of methanol due to scaling.	TXD05 (Duplex), UNS31500.
Acids	Organic acids (Acetic acid, fatty acids, formic acid)	Pitting & crevice corrosion caused by impurities in the form of chlorides present in acids.	TXD05 (Duplex), TXD07 (Super Duplex), TXK16 (Alloy625), C-276.
	Inorganic acids (Sulfuric, Phosphoric, Nitric, Hydrochloric)	Sulfuric: Acidic corrosion in coolers (loss of material), Phosphoric: Erosion, Deposits in heaters, Nitric: Condensation of nitric acid in cooler/condenser, Hydrochloric: Acidic corrosion (loss of material).	TXK05/TXK06 for Sulfuric acid & Phosphoric acid (Alloy 28, 904L), TXT19 (310L NAG)/ UNS32906, UNS32304 for Nitric acid, C-276/TXK16 (Alloy 625) for Hydrochloric acid.
Others	Caustic evaporators / Alumina digesters	Caustic Stress corrosion cracking, erosion corrosion.	UNS32304 / UNS32906, Nickel 200 / 201



# demands of the heat exchanger industry

The Tubacex Group can manufacture and supply straight and U bend Heat Exchanger tubing covering standard austenitic stainless steels, duplex stainless steels and high alloy austenitic stainless steels.



	STAINLESS STEEL GRADES					
	C %	Cr %	Ni %	Mo %	N %	OTHERS %
STANDARD AUSTENITIC	ASTM	Max	Min/Max	Min/Max	Min/Max	
	TP304L/304	0.03	18/20	08/12		
	TP316L/316	0.03	16/18	10/14	2.0/3.0	
	TP316/316L	0.03	16/18	10/14	2.5/3.0	
	TP321	0.08	17/19	09/12		5(C+N)-0.70
	TP321H	0.1	17/19	09/12		4(C+N)-0.70
	TP316Ti	0.08	16/18	10/14	2.0/3.0	0.1 5(C+N)-0.70
	TP304H	0.1	18/20	08/11		
	TP347H	0.1	17/19	09/13		8XC-1.10
	TP304LN	0.03	18/20	08/11	0.1/0.16	
	TP316LN	0.03	16/18	10/13	0.1/0.16	
	TP317L	0.03	18/20	11/15	3.0/4.0	
	TP310S/310H	0.08	24/26	19/22		
DUPLEX	UNS S31803	0.03	21/23	4.5/6.5	2.5/3.5	0.08/0.20
	UNS S32205	0.03	22/23	4.5/6.5	3.0/3.5	0.14/0.20
	UNS S32304	0.03	21.5/24.5	3.0/5.5	0.05/0.60	0.05/0.20 Cu-0.05/0.60
	UNS S32750	0.03	24/26	6.0/8.0	3.0/5.0	0.24/0.32 Cu-0.50 max
	UNS S32760	0.03	24/26	6.0/8.0	3.0/4.0	0.2/0.3 Cu-0.5/1.0,W-0.5/1.0
HIGH ALLOYED STEELS	UNS S31254	0.02	19.5/20.5	17.5/18.5	6.0/6.50	Cu-0.75 / N-0.2
	UNS N08904	0.02	19/23	23/28	4.0/5.0	Cu-1.4 / N-0.06
	UNS N08028	0.03	26/28	30/32	3.0/4.0	Cu-1.0
	UNS N08020	0.07	19/21	32/38	2.0/3.0	Cu-3.5 / Nb+Ta > 8C
	UNS N06600	0.04	14/17	72.0-min		Cu-0.5 max, Si-0.5 Max, Fe-8.0
	UNS N06601	0.1	21/25	58.0/63.0		Cu-1.0 max, Si-0.5
	UNS N06625	0.03	22/23	58.0-min	8.0/10.0	Co-1.0 / Cb+Ta 3.75 / Al-0.40 max / Ti-0.40 max
	UNS N06690	0.04	27.0/31.0	58.0-min		Cu-0.5,Si-0.5
	UNS N08800	0.1	19.0/23.0	30.0/35.0		Cu-0.75 max, Al-0.15/0.60, Ti-0.15/0.60
	UNS N08810	0.05/0.1	19.0/23.0	30.0/35.0		Cu-0.75 max, Al-0.15/0.60, Ti-0.15/0.60
	UNS N08811	0.06/0.1	19.0/23.0	30.0/35.0		Cu-0.75 max, Al-0.15/0.60, Ti-0.15/0.60
	UNS N08825	0.05	19.5/23.5	38.0/46.0		Al, 0.2 max, Ti 0.6/1.2
	UNS N02200	0.15/0.02		99.0 Min		Cu-0.25, Si-0.35, c-0.15 Max in 2200, 0.02 max in 2201
	UNS N04400	0.3		63.0-min		Cu-28.0/34.0, Si-0.5
	UNS N10276	0.01	14.5/16.5	57.0-min	15.0/17.0	W- 4.5 Max
	UNS N06022	0.01	20.0/22.5	54.0-min	12.5/14.5	W- 3.5 Max
MARTENSITIC	UNS S41000	0.15	11.5-13.5	0.50		Mn- 1.0 Max, Si-1.0 Max

Aceralava is Tubacex Group's steel melting shop, which provides the bulk of raw material supply for the rest of the Group's manufacturing units.

Aceralava's manufacturing range covers the main stainless steel grades requested by the industry as well as a tailor made list of steels. Our metallurgical engineers are devoted to the development of sophisticated steels capable of operating in the demanding environments of the future. Exceptions beyond the standard steel grades can be met upon request.

Grades out of Aceralava's manufacturing range (some high nickel alloys) are sourced from reliable suppliers.



# Customers in several key industries

Heat exchangers are important components in the oil & gas, refinery, chemical, petrochemical and power generation industries.

The need of higher efficiency in heat transfer processes and the need of improved characteristics against corrosion have increased the demand on the quality of the seamless stainless steel tubes used in these applications.

The Tubacex Group has a high competence on the development and manufacturing of such tubes. Our experience journey started in 1934 and has continued with a newly established Innovation center in Spain as well as a production footprint in Asia.

The Tubacex Group manufacturing range in tubes for heat exchanger applications cover the main applications where this equipment is needed:



## OIL & GAS

- Onshore processing unit
- Offshore platforms



## POWER GENERATION

- Condenser
- Heaters



## REFINERY

- Overhead condensers
- Sour water strippers
- React effluent air coolers
- Feed effluent air coolers
- Amine coolers
- Inter stage coolers



## PETROCHEMICALS

- Ethylene oxide/Ethylene Glycol
- LDPE/HDPE
- EDC/VCM



## ACIDS

- Organic acids: Fatty acids
- Formic/acetic acids
- Inorganic acids
- Sulfuric acid
- Phosphoric acid
- Nitric acid



## OTHER INDUSTRIES

- Pharmaceutical
- Paper
- Mining & Metals
- Salts



## RESEARCH & DEVELOPMENT

- The Tubacex Group has made a significant effort in innovation in recent years, which is constantly being reflected in results and in the sales figures. The Group has a corporate innovation unit called Tubacex Innovation, with human and technical resources devoted exclusively to innovation activities, consisting of R&D projects and development projects for the different industrial plants of the Group, in which technological development is required.

- TUBACEX R&D Center at Zamudio, Spain, is working continuously on bringing out upgrades in metallurgy and properties of steel.

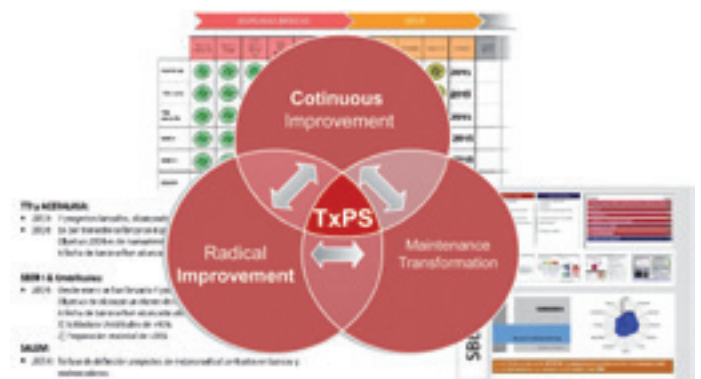


## TUBACEX PRODUCTION SYSTEM

TxPS, the acronym of Tubacex Production System, is the standard Management System for the entire Tubacex Group focused on:

- Implementing a continuous improvement system in all areas
- Involving all personnel from all areas
- Ensuring that the improvements are sustained over time

TxPS is based on action on three levels: yearly management plan, daily management and specific action for radical improvement.



## TUBACEX SERVICE SOLUTIONS

- Tubacex Service Solutions is the Tubacex service center through which we try to provide complete packages of tubes and pipes in various sizes, grades and quantities. It is also possible to provide small quantities with fast delivery catering to maintenance shut down requirements.

- The Group's network of service centers in Europe, America and Asia offers availability and proximity to our customers. TSS-TUBACEX-strives to provide a complete solution to customer needs and not just tubes. This includes value added operations for small niches such as:
  - Final treatments
  - Special packages
  - Others



## WIDEST PORTFOLIO

- Tubacex's manufacturing range starts at 3 mm O.D. in Salem Tube.

- IBF, one of the group companies located in Italy, can produce thin walled and thick walled higher outside diameter Tubes & Fittings from 8" to 72" in all grades (Carbon steel, Alloy steel, Titanium, Stainless steel). As a result of those manufacturing capabilities, Tubacex has the widest portfolio in the Stainless Steel industry.



## OTHER PRODUCT APPLICATIONS

Tubacex offers a wide range of products in the stainless steel tubular solutions industry.

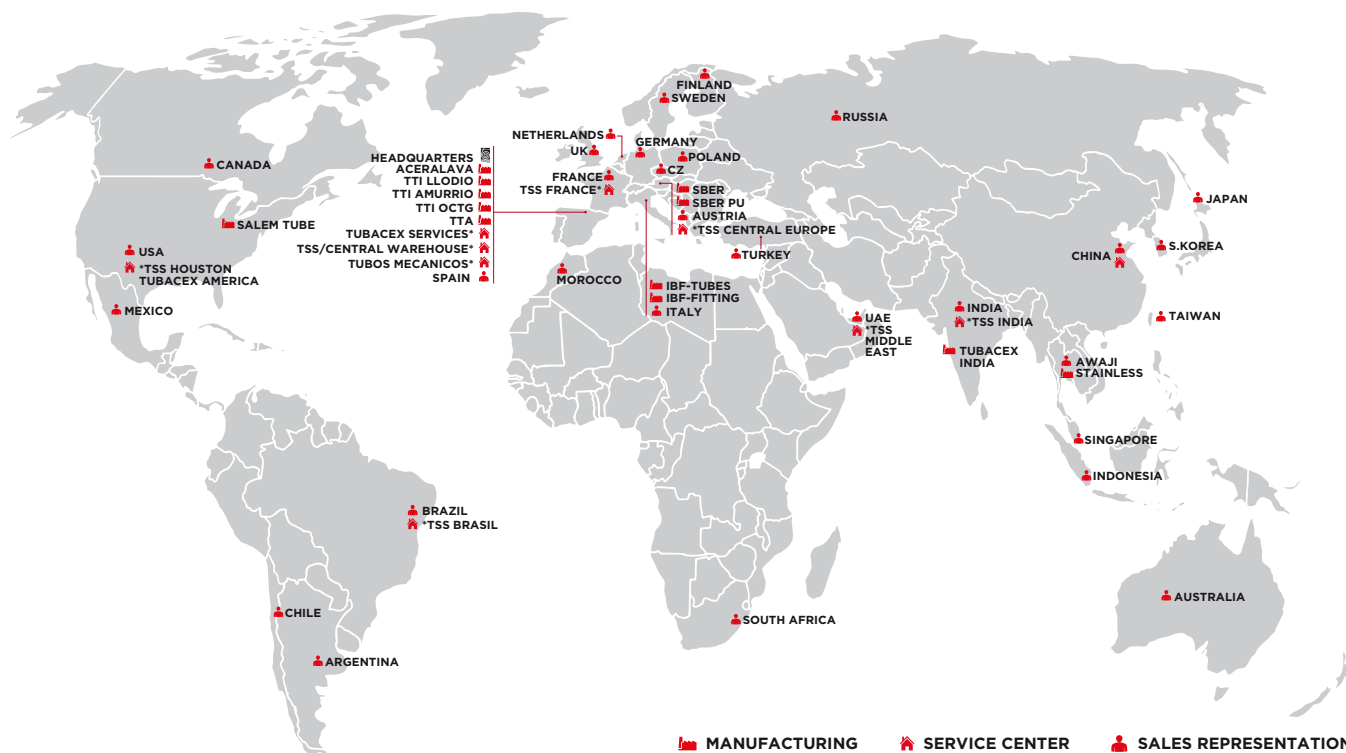
Tubacex also supplies tubes and pipes for Fertilizer / Urea application, Umbilicals, Risers and flowlines for subsea applications, OCTG pipes, tubes for Boilers, Hydraulic & Instrumentation tubing, Precision tubing, Furnace tubes, Bars (above 165 mm OD) & Hollow bars.





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