Saint-Gobain Life Sciences

A Guide to Navigating Tubing Materials for Bioprocessing Applications

SAINT-GOBAIN
YOUR **BIOPROCESSING** PARTNER

SAINT-GOBAIN

INTRODUCTION

Making the selection of suitable tubing materials is critical for biopharmaceutical applications. Choosing the wrong tubing can have undesired impacts such as drug contamination and reduced process efficiency.

This guide is designed to help you navigate the wide range of tubing materials commonly used in bioprocessing. It outlines the key properties, benefits, and limitations of each option - empowering you to make informed decisions tailored to your specific needs.

MATERIAL SELECTION CONSIDERATIONS

FLUID/CHEMICAL COMPATIBILITY

The tubing material must be chemically compatible to the fluids being used. Reactions between the fluid and tubing can lead to leaching and contaminations as well as degradation, jeopardizing product quality and process safety. Temperature, concentration, and other chemicals can affect how a material behaves in a process. So, it's important to test with the actual fluid and conditions you will use. Refer to the Chemical Compatibility Guide for detailed recommendations.

TEMPERATURE

Consider the operating relative temperature ranges of your process. Some materials exhibit excellent thermal stability while others are more susceptible to degradation at high or low temperatures.

PRESSURE AND VACUUM

Tubing under pressure may experience burst failure and tubing under vacuum may experience tube wall collapse. Besides the material of construction, it is important to note that burst pressure and vacuum resistance is a function of tubing sizes. Careful consideration should be given to the pressure and vacuum capabilities.

FLEXIBILITY AND BEND RADIUS

Tubing flexibility impacts installation ease and overall system design. Materials with a tight bend radius can navigate complex configurations, while rigid materials may require more manufacturing space or redesign of the layout.

STERILIZATION

Your chosen method of sterilization, whether steam, gamma, x-ray, ethylene oxide, or cleaning and sterilization in place (CIP/SIP) must be compatible with the tubing materials used. Incompatibility between tubing materials and sterilization or cleaning processes can lead to rapid tubing deterioration, potentially resulting in process failure and drug contamination.

PUMPING

Pumping is very common in many bioprocessing applications, especially via peristaltic pumps. Different materials and dimensions (e.g., tubing wall dimensions) have varying capabilities for pumping duration as well as dosing accuracy and spallation generation.

SPALLATION

Microparticle shedding from tubing under mechanical stress can compromise product purity in sensitive bioprocesses. This is especially critical in peristaltic pump applications. Choosing low-spallation tubing is essential for maintaining purity and meeting regulatory standards.

EXTRACTABLES

All tubing materials generate varying levels of extractables during regular processing. The type and extent of extractable compounds should be assessed to ensure process capability. Refer to our extractable reports to determine suitability of use.

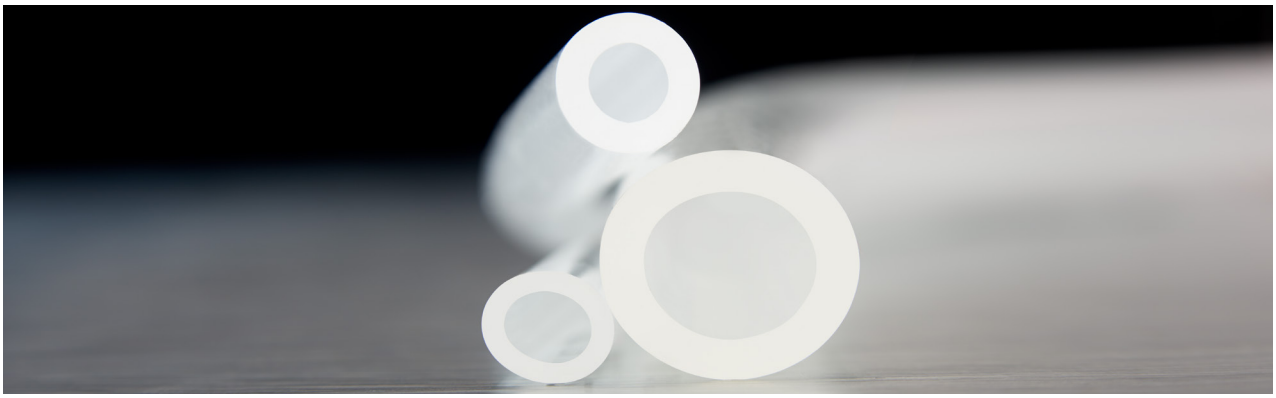
REGULATORY AND VALIDATION COMPLIANCE

Ensure your tubing meets relevant regulatory standards, such as REACH and RoHS requirements, and validation criteria, such as biocompatibility and cleanliness testing, to guarantee product safety and efficacy. Single-use suppliers typically document all such available data in validation guides, regulatory information overviews (RIOs), and/or technical dossiers.

CONNECTION

There are many options to consider for connecting tubing from one part of a system to another (e.g. single barb, multi-barb, welding, push-to-connect, compression). When retrofitting tubing into an existing system, the fittings may be a limiting factor when selecting a tube material.

COMMON TUBING MATERIALS IN BIOPROCESSING



THERMOPLASTIC ELASTOMER (TPE) KEY PROPERTIES

TPE tubing provides a well-balanced combination of chemical resistance, flexibility, and durability. It is often used as an alternative to silicone in applications where relative temperature resistance or frequent sterilization is not required. TPE is also ideal when sealing or welding is necessary, or when low permeability and minimal absorption are critical.

ADVANTAGES

- Good compatibility with a wide range of fluids
- Sealable and weldable
- Some display excellent pumping capability
- Low permeability and absorptions

LIMITATIONS

- Some variations lack clarity
- Extractable content
- Limited chemical resistance to acids, alcohol, hydrocarbons, and oils
- Limited temperature resistance (-67°C/-59°C to +135°C)

TPE APPLICATIONS

- Fluid transfer
- Peristaltic pumping
- Drug delivery and pharmaceutical filling
- Fermentation and bioreactor processes

See the 'Tubing Guide' chart to identify the best features for your application.

SAINT-GOBAIN OFFERINGS

- C-Flex® 374*
- C-Flex® Braided
- PharmaPure®*
- C-Flex® 072
- PharMed® BPT®

*Available for sustainable ValPlus™. See 'Sustainability' section.

SILICONE KEY PROPERTIES

Silicone tubing is renowned for its exceptional biocompatibility, flexibility, and chemical resistance. It can withstand a wide temperature range (-80°C to 260°C) and repeated autoclave sterilization cycles, making it a versatile choice for various bioprocessing applications.

ADVANTAGES

- Inert to several biological fluids and cell cultures
- Excellent flexibility for easy installation and maneuverability
- High purity with low extractables
- Can be safely used between a large range of temperature (-80°C to 260°C)

LIMITATIONS

- Higher carbon footprint compared to alternatives
- Cannot be sealed or welded
- Challenges in recycling
- Higher gas permeability

SILICONE APPLICATIONS

- Peristaltic pumping
- Cell culture media and buffer transfer
- Drug delivery and pharmaceutical filling
- Fermentation and bioreactor processes

See the 'Tubing Guide' chart to identify the best features for your application.

SAINT-GOBAIN OFFERINGS

Sani-Tech® tubing products:

- STHT®-C*
- STHT®-65*
- STHT®-80*
- STHT®-R*
- STHT®-R-HD
- STHT®-WR
- SPT-60L*
- Ultra-C
- Ultra-65

*Available for sustainable ValPlus™. See 'Sustainability' section.

THERMOPLASTICS (TP) KEY PROPERTIES

TP tubing provides low gas permeation compared to silicone, protecting sensitive fluids. The smooth inner surface minimizes microbial build-up, making it ideal for aseptic filling, diagnostic equipment, and laboratory use.

ADVANTAGES

- Low extractables
- Broad chemical resistance

TP APPLICATIONS

Fluid transfer for:

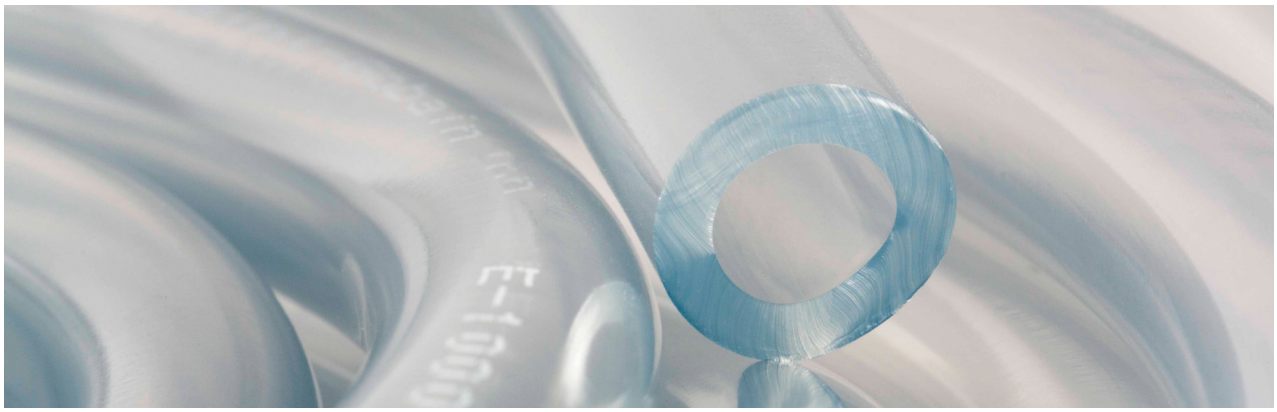
- Aseptic filling and dispensing systems
- Diagnostic equipment
- Laboratory analytical instrumentation
- Cell and tissue culture transport

LIMITATIONS

- Relatively low temperature resistance (Max. temperature 125°F (52°C))
- Lower elasticity than other plastics - no peristaltic pumping

SAINT-GOBAIN OFFERINGS

- Tygon® 2475
- Tygon® 2475 IB



POLYVINYL CHLORIDE (PVC) KEY PROPERTIES

PVC tubing is chosen when monitoring is important and quick seal and weld are critical. Saint-Gobain Life Sciences' Tygon® tubing for bioprocessing applications has been formulated with non-DEHP bio-based plasticizers for reduced environmental impact.

ADVANTAGES

- Clear tubing, for ease of monitoring
- Sealable and weldable
- Broad chemical resistance
- Cost-effective

PVC APPLICATIONS

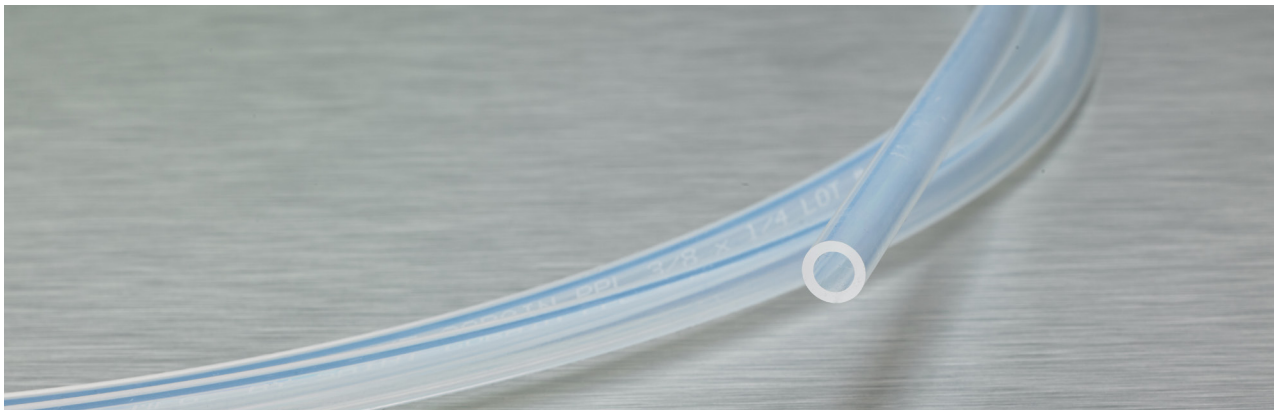
- Biopharmaceutical processing
- Cell & Gene therapy
- General laboratory
- Analytical instruments
- Condensers, incubators, desiccators, gas lines, and drain lines
- Pumping

LIMITATIONS

- Limited temperature resistance of ≤ 165°F (74°C)
- Limited chemical resistance when it comes to alcohol, solvents, oils, some acids and others
- High potential for extractable content
- Higher carbon footprint compared to alternatives

SAINT-GOBAIN OFFERINGS

- Tygon® Lab E-3603
- Tygon® Lab E-1000
- Tygon® ND-100-80
- Tygon® Lab E-LFL
- Tygon® ND-100-65



FLUOROPOLYMER (FEP) KEY PROPERTIES

FEP tubing is a versatile tubing material used in a variety of industries due to its unique properties. This material is well known for its exceptional purity, chemical resistance, and temperature stability. The different types of fluoropolymer tubing include PTFE (polytetrafluoroetyhylene), PFA (perfluoroalkoxy), and FEP (fluorinated ethylene propylene). Saint-Gobain Life Sciences' PharmaFluor® FEP tubing is designed to meet the highest demands of biopharmaceutical, medical, and laboratory applications.

ADVANTAGES

- Accurate dosing for transfer tubing (post-pumping) due to rigidity, preventing pulsation
- Durable with high chemical and temperature resistance
- Transparent for easy fluid monitoring
- Excellent barrier properties against gases and aqueous solutions
- High purity, low extractables
- Well-suited for autoclaving and EtO sterilization

FEP APPLICATIONS

- Chemical processing of highly corrosive fluids
- Critical fluid transfer in filling equipment for bioprocessing and lab equipment such as chromatography systems

LIMITATIONS

- Not for applications requiring gamma-irradiation
- Not suitable for use with peristaltic pumping
- Due to fluoropolymer tubing rigidity, connections like hose barbs do not work well. Compression, push-to-connect, and flared fittings are recommended for a tight seal

SAINT-GOBAIN OFFERINGS

- PharmaFluor®*

*Available for sustainable ValPlus™. See 'Sustainability' section.

TUBING CONSTRUCTION

In bioprocessing, the construction of tubing plays a vital role in determining its performance in specific applications. By understanding the nuances of different tubing constructions, bioprocess engineers can ensure the optimal performance of their operations.

SINGLE EXTRUSION

The simplest form of construction, single-material extrusions are also the most common and are able to meet many functional needs for fluid transfer in bioprocessing.

Saint-Gobain offerings:

- **C-Flex® 374*/072**
- **Sani-Tech® STHT®-C*/65/80**
- **Sani-Tech® Ultra-C/65**
- **Sani-Tech® SPT-60L***
- **Tygon® 2475**
- **Tygon® Lab E-3603**
- **Tygon® Lab E-1000**
- **Tygon® Lab E-LFL**
- **Tygon® ND-100-65**
- **PharmaFluor®***
- **PharMed® BPT®**

CO-EXTRUSION

The co-extrusion manufacturing process brings together two or more layers of different materials into a single tubing product. This can be beneficial in creating multifunctional layers that can mitigate the weaknesses of one material with the strengths of another. There are limitations as not all materials bind well to each other.

Saint-Gobain offerings:

- **PharmaPure®**

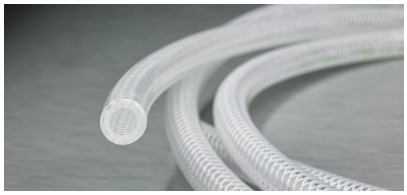
MULTI-LAYER

The multi-layer manufacturing process incorporates two or more materials into a single tubing product. This adds the reinforcement needed for relatively high pressure applications.

Saint-Gobain offerings:

- **Sani-Tech® STHT®-R***
- **Sani-Tech® STHT®-R-HD**
- **Sani-Tech® STHT®-WR**
- **C-Flex® Braided**
- **Tygon® 2475 IB**

*Available for sustainable ValPlus™. See 'Sustainability' section.



BRAID REINFORCED

Special manufacturing processes and equipment can add braided polyester or nylon between separate layers of extruded tubing. The braid reinforcement greatly increases the pressure resistance of the tubing product allowing it to operate in high pressure applications.

Saint-Gobain offerings:

- **Sani-Tech® STHT®-R***
- **C-Flex® Braided**
- **Tygon® 2475 IB**

DOUBLE-BRAID REINFORCED

Double-braided tubing can be valuable in applications requiring exceptional durability and pressure resistance, such as:

- High-pressure transfer of process fluids
- Specialized bioreactor designs

This method of construction creates two layers of braid reinforcement between three layers of extruded tubing providing even greater pressure resistance capabilities than single-braid reinforcement options.

Saint-Gobain offerings:

- **Sani-Tech® STHT®-R-HD**

BRAID AND WIRE REINFORCED

The most heavy-duty method of construction has two reinforcing layers between three layers of extruded tubing. One reinforcing layer contains polyester or nylon braiding while the other contains both braiding and stainless steel wire. The wire reinforcement helps to achieve the high burst pressure capabilities of the double-braid method while additionally creating a vacuum-resistance capability.

Saint-Gobain offerings:

- **Sani-Tech® STHT®-WR**

SUSTAINABILITY

At Saint-Gobain Life Sciences, we believe that responsible manufacturing is crucial in building a sustainable future. We create innovative solutions that meet the rigorous demands of your applications and drive positive environmental change. Our commitment to sustainability is woven into every aspect of our operations, including tubing products offerings.

OUR FOOTPRINT

We are committed to minimizing our environmental impact. Currently, 60% of our plants have achieved the Environmental Management certification ISO 14001, reflecting our dedication to sustainable operations. Several of our tubing production sites, including those in North America, are powered by renewable energy through three Virtual Power Purchase Agreements (vPPAs) established in 2020, 2022, and 2023. We are also localizing our production sites to reduce transportation-related emissions and enhance efficiency. Additionally, Saint-Gobain Life Sciences is increasing the recycling of internal scraps, actively avoiding the disposal of waste in landfills or through incineration.

OUR OFFER

Saint-Gobain Life Sciences' ValPlus™ certification program ensures cleanliness, quality, and validation for biopharmaceutical tubing, eliminating the need for costly and time-consuming Water for Injection (WFI) rinsing. This significantly reduces both water usage and energy consumption. By meeting stringent standards for endotoxin, bioburden, and particulate levels, ValPlus™ also streamlines validation and reduces contamination risks. ValPlus™ options are available across our tubing portfolio, and more details - including a list of products - can be found in our white paper titled Mitigate Risk, Lower Overall Cost, and Enhance Sustainability Efforts with Saint-Gobain ValPlus™ Certification. In addition to water conservation, we are committed to advancing recycling efforts for materials like TPE and silicone. While mechanical recycling is suitable for TPE and more challenging for silicone, chemical recycling is becoming increasingly accessible in regions such as the US and Asia. We can also help connect you with recyclers based on your operating region. For more information, please contact us at sustainability.bps@saint-gobain.com.

LIFE CYCLE ASSESSMENT

Saint-Gobain Life Sciences is committed to transparency, using LCA to evaluate the environmental impact of its products. With a goal to cover 100% of its portfolio with LCA by 2030, the company drives sustainability and continuous environmental improvement. If you are interested in getting some of our LCAs please contact sustainability.bps@saint-gobain.com.

CONCLUSION

Selecting the right tubing material is paramount for achieving optimal performance, maintaining product integrity, and ensuring process efficiency in bioprocessing. By understanding the key properties and limitations of each material, you can confidently navigate the diverse options and choose the best solution for your specific needs.

Saint-Gobain Life Sciences offers a comprehensive portfolio of tubing materials designed to meet the stringent demands of the biopharmaceutical industry. Our commitment to quality, innovation, and support ensures that you have access to the most reliable and high-performance tubing solutions for your critical applications.

TUBING RECOMMENDATION CHART

Material Type	Tubing Type	Pump Life	Burst Pressure	Vacuum	Weld and Seal	Overmold	Chemical Resistance	Permeability
FEP Tubing	PharmaFluor®	X	+++++	Y	N	N	+++++	Low
TPE Tubing	C-Flex® 072	+++	+++	Y	Y	Y	+++	Low
	C-Flex® 374/082	+	++	Y	Y	Y	+++	Low
	C-Flex® Braided	X	+++++	Y	Y	Y	+++	Low
	PharmaPure®	+++++	+++	Y	Y	N	+++++	Low
	PharMed® BPT	+++++	+++	Y	Y	Y	+++++	Low
TP Tubing	Tygon® 2475	X	++++	Y	N	N	++++	Low
	Tygon® 2475 I.B.*	X	+++++	Y	N	N	++++	Low
Silicone Hose	Sani-Tech® STHT®-R*	X	+++++	N	N	Y	+++	High
	Sani-Tech® STHT®-R-HD***	X	+++++	N	N	Y	+++	High
	Sani-Tech® STHT®-WR**	X	+++++	Y	N	Y	+++	High
Silicone Tubing	Sani-Tech® SPT-60L	++++	++	N	N	Y	+++	High
	Sani-Tech® STHT®-65	+	++	N	N	Y	+++	High
	Sani-Tech® STHT®-80	X	++++	Y	N	Y	+++	High
	Sani-Tech® STHT®-C	+	+	N	N	Y	+++	High
	Sani-Tech® Ultra-65	+	++	N	N	Y	+++	High
	Sani-Tech® Ultra-C	+++	+	N	N	Y	+++	High

The recommendations in the table provide general guidance and are not based on comparative experimental data.

Please see Chemical Resistance Guide for specific chemical interactions with product of interest.

X = not recommended
Y = yes
N = no

* = braid-reinforced
** = double braid-reinforced
*** = braid and wire-reinforced

BIOPROCESS TUBING CATEGORIES

ESSENTIAL TUBING

SPECIALTY TUBING

SUSTAINABLE TUBING

OUR PILLARS OF COMMITMENT

RELIABILITY

With an extensive global manufacturing footprint and industry-leading quality system, Saint-Gobain Life Sciences is committed to ensuring the reliable performance, durability, safety, and on-time delivery of tubing products to help customers in critical pharmaceutical applications. Our global manufacturing footprint helps us meet the local needs of customers around the world.

EXPERTISE

Saint-Gobain Life Sciences offers a broad selection of tubing materials and sizes to meet the diverse needs of our customers. Backed by decades of experience and a track record of cutting-edge innovation in material science, our experts can provide comprehensive technical support by helping with material selection, compatibility assessment, and optimization to ensure the best performance and process outcomes.

REGULATORY

Saint-Gobain Life Sciences adheres to stringent quality standards and regulatory compliance to guarantee the reliability and safety of our tubing products. Committed to transparency, we make it simple for you to access important information, including our comprehensive Regulatory Information Overview (RIO), available for download on our website here.

SUSTAINABILITY

Saint-Gobain Life Sciences is committed to delivering innovative solutions for the biopharmaceutical market that maximize impact for our customers, while minimizing our footprint. We support sustainable bioprocessing by developing alternative materials, minimizing packaging waste, and planning recycling programs.