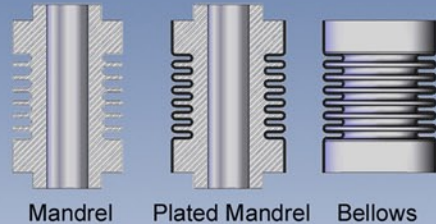


ELECTROFORMED NICOLOY® BELLOWS



Bellows are dynamic components requiring a combination of strength, elasticity and long cycle life. NiColoy®, NiCoForm's proprietary Nickel/Cobalt alloy, is perfectly suited for bellows electroforming for several important reasons. Not only does NiColoy exceed nickel in mechanical strength, corrosion resistance, and durability, it also allows us to produce components that do not undergo permanent deformation at rated loads.

In electroforming, metal is uniformly electroplated onto a conductive substrate of the desired configuration called a mandrel. After the required thickness of the plated layer is deposited, the mandrel is either removed mechanically or dissolved by chemical means leaving a free standing electroformed component as shown in the illustration .



Metal bellows can be manufactured by several methods - rolling, welding, hydroforming, chemical deposition, and electroforming. As described below, electroformed bellows possess a number of advantages over the other types. Additionally, the higher mechanical strength of NiCoForm's proprietary NiColoy® enables us to electroform bellows that outperform conventional nickel bellows.

- NiCoForm's proprietary nickel-cobalt alloy, NiColoy®, has a higher Modulus of Elasticity, Ultimate Tensile and Yield Strength than conventional electroformed nickel (see table below). This translates into greater flexibility, higher pressure and torque ratings for NiColoy® bellows compared to standard nickel bellows.
- Electroforming allows producing bellows with walls as thin as 0.0004" (10 µm), making them ideal for highly responsive sensor applications or low pressure differential sensors.
- Non-electroformed types of bellows contain inherent stresses imparted to them during manufacturing (welding, rolling, hydroforming). At NiCoForm, electroforming is accomplished in a controlled environment resulting in stress free bellows. This increases the components' durability under cyclical loads. Our bellows are normally designed for 250,000 cycles, but infinite life designs can be produced, if necessary.
- Homogenous and nonporous, electroformed NiColoy® bellows can be used to seal out moisture and dust in critical applications. Leak testing of bellows can be performed by helium mass spectrometer to 10E-7ccHe/min, or lower.
- Electroformed bellows can be much smaller than other types while retaining all of their sensitivity and flexible qualities. Bellows as small as 0.03" in outside diameter can be electroformed with great precision. On the other end of the spectrum, NiCoForm has the capability to produce bellows up to 10" in diameter and as long as 25".
- NiColoy® retains its strength and elastic properties at higher temperatures than Nickel and can be used from well below freezing to 600°F.
- NiCoForm has refined its electroforming process to maximize wall uniformity and reduce the in-tank time. Thus, the product consistency is increased and short turn around time is made possible.



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ELECTROFORMED BELLOWS APPLICATIONS

There is a vast array of applications in a wide variety of industries that are currently using electroformed bellows. Below is a partial list of these applications.

- Accumulators
Actuators/Pistons
- Expansion Joints
Pressure
Thermal
- Sensors
High Sensitivity Pressure
Temperature
- Couplings
Flexible Shaft
Low Inertia
Low Windup
Torque
- Dynamic Pump Housings
- Seals
High Pressure/Vacuum
Mechanical Shaft
Valve Stem
- Volume Compensators

Comparative Properties of NiColoy® and Nickel

Property	High Hardness NiColoy®	High Strength NiColoy®	Electroformed Nickel	Comments
Ultimate Tensile Strength (psi)	160,000 min.	125,000 min.	91,500	NiColoy® has a higher breaking point than Nickel
Yield Strength (psi)	125,000 min.	110,000 min.	61,000	NiColoy® resists permanent deformation better than Nickel
Modulus of Elasticity in Bending (psi)	24,000,000	22,000,000	21,000,000	NiColoy® has higher elasticity than Nickel.
Poisson's Ratio	0.31	0.31	0.31	
Shear Modulus (psi)	9,200,000	8,400,000	8,000,000	
Elongation at Break	1-3%	3-5%	15-25%	
Composition	Nickel - 95% min, Cobalt - balance	Nickel - 85% min, Cobalt - balance	Nickel	
Max Temp Rating (°F)	600	600	350	NiColoy® retains its mechanical properties at a higher temperature than Nickel.

Whether you have an existing design, a design in progress, or a completely new application, let our friendly engineering staff help you with your bellows needs. At NiCoForm, we offer custom engineered bellows at off-the-shelf component pricing.



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