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Tensile Testing of Hypodermic Needles

Use of a hypodermic needle is the most direct method for administering medication. The medication is usually injected intramuscularly, where there is a rich supply of blood vessels, or intravenously, allowing the medication to be absorbed into the blood stream and begin acting almost immediately. Hypodermic needles are usually manufactured out of stainless steel and the material and design must be tested to evaluate the needle's maximum tensile strength and yield strength. The challenge in testing these tubular devices is in gripping the specimen without causing premature failure in the grip faces.

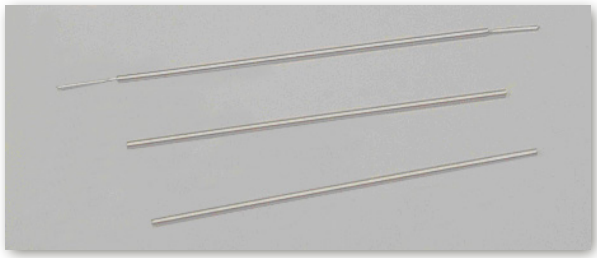

Figure 1:
Needle specimens; top specimen is shown with a staple insert at each end.

Test Configuration and Sample Preparation

The Instron® 5569 electromechanical testing system with a 5 kN load cell and 5 kN pneumatic side action grips were used to perform this test. Pneumatic grips are instrumental in this type of test because they allow the user to specify the gripping pressure to an exact value, which may change depending on the material under test. For this sample, a pressure of 85 psi was used. The faces used in each grip were one 1 × 1 in rubber-coated face and one 1 × 1 in metallic face. This combination is unique to the application and provided cushioning of the specimen at maximum load as well as strength to prevent slipping of the specimen at maximum load.

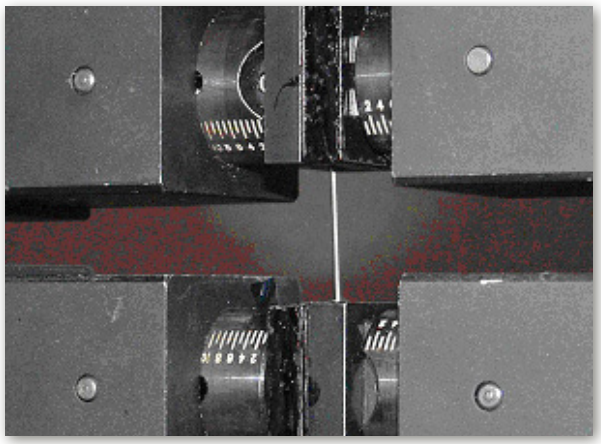

Figure 2:
Needle specimen set-up for testing in tension.

The needle specimens were manufactured out of stainless steel and had an outer diameter of 0.036 in, an inner diameter of 0.023 in and a length of 2.0 in. The grip separation, or gauge length, was set to 0.9 in, a value determined by the length of the specimen and the size of the grip faces.

Before inserting the specimen into the grip faces, it was necessary to plug the inner diameter of the specimen at each end. The plug was inserted to a position that slightly exceeded the length of the grip faces. The purpose of the plug was to prevent collapse of the gripped ends but not interfere with the gauge area. For these needles, straightened standard staples were used as inserts. The diameter of the staple was small enough to fit into the inner diameter of the needles. A specimen with an insert and two without are shown in Figure 1.

With both inserts in place, the specimen was loaded into the grip faces, as shown in Figure 2. Using a test speed of 0.1 in/min, the specimen was tested in tension until failure. For each specimen, failure occurred within the gauge area, ensuring that the test was conducted successfully. A broken specimen is shown in Figure 3.

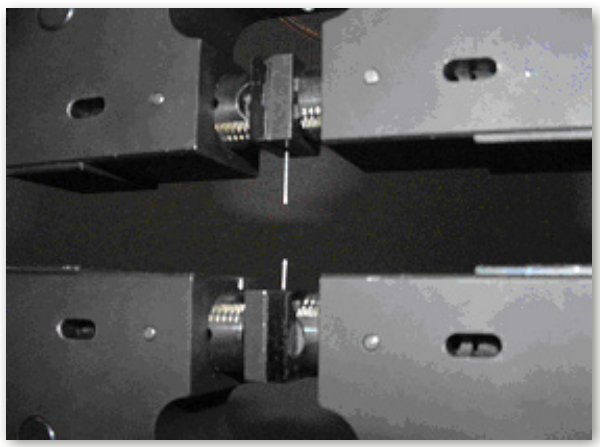

Figure 3:
Failure of the tubular specimen occured within the gauge area as a result of solid inserts and dual surface grip faces.

Results

The following results were obtained from five specimens. The graph is marked with the modulus line, 0.2% yield point, maximum load and break load.

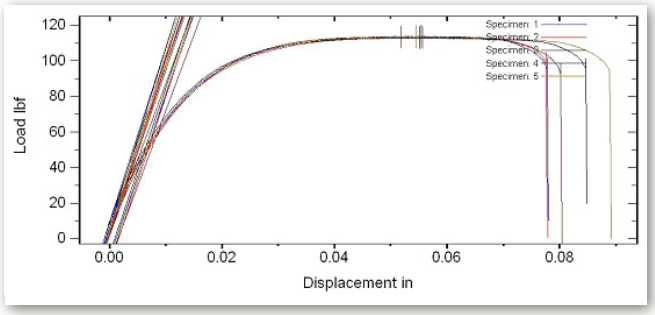

Figure 3:
Graphical results for the five hypodermic needle specimens tested in tension until failure. Shown in the graph are the elastic modulus and 0.2% yield lines and maximum load.

Conclusions

Based on the fact that all specimens broke within the gauge area and that there is repeatability and reliability of the results, it can be concluded that this test configuration is appropriate for testing hypodermic needles of all lengths and diameters.

The two key features of this test configuration are the dual surface grip faces and the specimen inserts. The dual surface grip faces prevent slipvr of the tubing. This technique prevents collapse, and consequently, premature failure of the tubing at the grips face during a tension test.

Specifications

Sample Number	Max Load	Tensile Strength	Max Strain	Break Load	Stress at Break	Stress at Break	Load at 0.2% Yield	Stress at 0.2% Yield
	lbf	ksi	%	ibf	ksi	%	ibf	ksi
1	113.701	188.746	6.164	95.033	157.758	8.643	52.454	87.075
2	112.948	187.497	6.190	98.472	163.466	8.613	51.737	85.886
3	113.372	188.200	5.752	92.027	152.766	8.918	56.568	93.905
4	112.817	187.279	6.114	94.911	157.555	9.409	52.135	86.545
5	113.432	188.306	6.062	71.490	118.675	9.893	51.817	86.018
Mean	113.255	188.006	6.056	90.387	150.044	9.095	52.942	87.886

Table 1:
Results and statistics for the five hypodermic needle specimens tested in tension.

Configuration Table

Catalog Number	Configuration Options	Description
5569	Frame	Dual column frame
2525-805	Load Cell	1000 lb (5 kN) capacity
2712-012	Fixtures	5 kN pneumatic side acting grips
2702-107		25 × 25 mm (1 × 1 in) rubber-coated faces
2702-108		25 × 25 mm (1 × 1 in) serrated faces

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