Study of nitrile material on hydro packing seal

Pawar Pavankumar J, Prof Yogita potdar

PG Scholar at Kls gogte institute of technology, belagavi
Professor at kls gogte institute of technology
Department of mechanical engineering

Abstract – In *this project an effort has been made to carry out an experiment on Nitrile SEAL material, the project requires a basic knowledge of the material science and mechanics of solid. The report includes a general overview of the Nitrile SEAL material The stress distribution on both materials can be understood, stress strain acting on the both material is estimated. for find out tensile strength, yield strength, and modulus of elasticity, tensile ,compression test are conducted on Nitrile material with help of universal testing m/c.*

Index worlds – nitrile material, soft rubber.

1. INTRODUCTION

Nitrile rubber is used mostly where high oil resistance is required, as in gaskets, and in automotive seals or other items which are subject to contact with hot oils. The rolls for spreading ink in printing and hoses for oil products are other common uses. NBR is also used in textiles, where its application to woven and no woven fabrics improves the finish and water proofing properties. A black acrylonitrile butadiene rubber usually referred as NBR, Nitrile or Buna.

2 .MATERIAL SELECTIONS

A) Dumb-bells are preferable for determination of tensile strength. Rings give lower, sometimes much lower, values than dumb-bells

B) O-ring is used for compression test.

3 .EXPERIMENTAL SET-UP

Miniature test pieces might give usually higher, somewhat different values for tensile strength and elongation at break than the large test pieces.

Seven different type test pieces are provided, i.e. dumb-bells type (1, 2, 3 and 1A) and in ring shaped case A (normal) and B (miniature). The results obtained will be vary according to the type of test pieces is used and the results obtained for different materials should therefore not be regarded as comparable unless the same type of test pieces has been used.

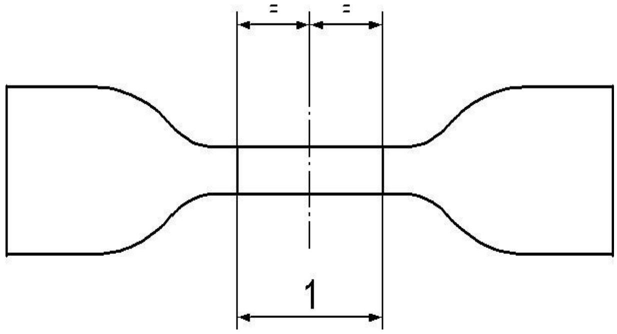


Figure 3.1 — Shape of dumb-bell test pieces

4 .TENSILE TEST

Dumb-bells are preferable for determination of tensile strength. Rings give lower, sometimes much lower, values than dumb-bells. Fig 3.1 shows the dumb-bell shape material used for tensile testing.

4.1 Tensile-testing machine

In this testing the tensile-testing machine shall comply with the all the requirements of ISO 5893, having an accuracy complying with class D for type 1,1A and 2 dumb-bells Test pieces and class E for type 3 and 4 dumb-bell test pieces.

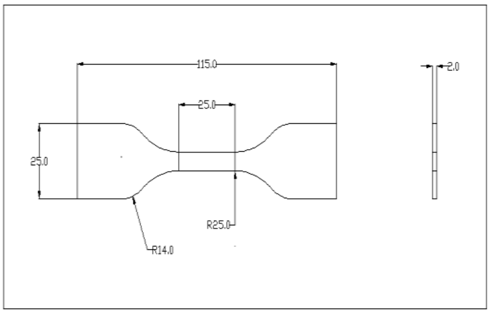


Fig 4.1- Dumb-bell specimen

4.2 Preparation of test pieces and sample

Vulcanization is a process which is used to adapt a natural rubber into robust material. This is actually a chemical process in which sulfur is added to the natural rubber composition or other comparable curatives or accelerators. Due to vulcanization process polymer composition get modified by forming cross links bridges between individual polymer chains as shown in above fig, which increases the mechanical properties of the material and makes material less sticky. Protection of test pieces and samples are one of the most important things, damage may occur to the test pieces from external influence during the interval between vulcanization and testing such as light and heat.

4.3 Procedure-

Tensile testing of dumb-bell test pieces first insert the test piece into the tensile-testing machine; make shore that the end tabs are gripped symmetrically so that the tension is distributed uniformly over the cross-section. It is strongly recommended that the load cell be reset to its initial or neutral position, which is zero before each test. Then apply a prestress of 0.1MPA sp that the test pieces is not bent when the initial test length is measured as shown in Fig2. If necessary, setup the extensometer device. Start the machine and monitor continuously the change in test length and force trough out the test to an accuracy of 2%. The nominal rate of traverse of the moving grip shall be 500mm/min for type 1, type 2 and type 1A test pieces and 200mm/min for type 4 and type 3 test pieces. Any test piece that breaks outside the narrow portion or yields outside the test length shall be discarded and a repeat test conducted on an additional test piece.

Table4.1- Experiment results

Compound code- Nitrile	Fractured sample
Stress strain property	
1) 100% modulus, kg/cm^2	30
2) 300% modulus, kg/cm^2	100
3) Tensile strength, kg/cm^2	125
4) Elongation at break, %	380
5) Specific gravity	1070

4.4 calculation

We know the tensile strength-125 kg/cm^2

1) Maximum stress $= \frac{\text{Tensile strength} \times \text{specfic gravity}}{100}$

$= \frac{125 \times 9.81}{100}$

=12.26MPA

2) Maximum force = Maximum stress × cross section area

= 12.26× 12.4

= 152.084N

5 .COMPRESSION TESTING

5.1 Compression device

Fig 5.1- compression testing device

The device consists of steel plates which are two or more number between these parallel plates specimens may be compressed as shown in fig (5.1). Surface contact between steel plate and rubber specimen ground to a maximum roughness of 250µm (10µm), and thin chromium plated and polished.

The number of test pieces should preferably be decided in advance, bearing in mind that the use of five test pieces will give a lower uncertainty than a test with three test pieces.

Fig 5.2-nitrile o-ring

5.2 Preparation of test pieces and sample

Vulcanization is a process which is used to adapt a natural rubber into robust material. This is actually a chemical process in which sulfur is added to the natural rubber composition or other comparable curatives or accelerators. Due to vulcanization process polymer composition get modified by forming cross links bridges between individual polymer chains as shown in above fig, which increases the mechanical properties of the material and makes material less stick

5.3 Hardness test of test specimen

Fig 5.3 – Durometer scale (hardness testing apparatus)

Durometer scale is principal apparatus which used to determine the rubber material hardness. Following are the few case examples hardness of rubber material, and most of the rubber materials come under the rubber durometer scale of shore.As shown in above fig 5.3, the testing of hardness of NITREILE material, first step in the process is keeping specimen on the platform and then with help of durometer pointer we apply 10N load on each material to find out its hardness. Following are the results we get during the test.

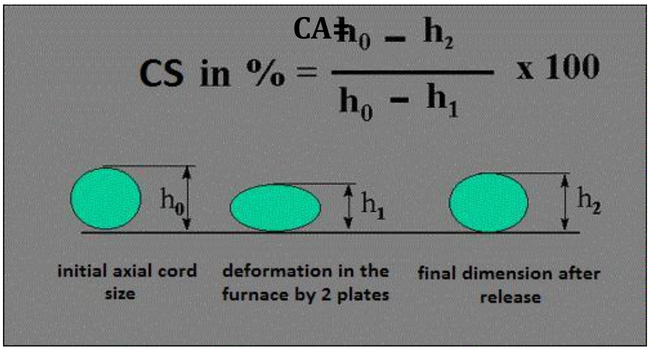
NITRIEL – 65-70A (In this case, tolerance of the durometer is always considered as 5%.)

5.4 Procedures

First step is measure the original thickness of test pieces to the closet 0.02mm (0.001in). Then pieces place on the anvil of the dial micrometer so that the presser foot will indicate the thickness at the central part of the bottom and as well as top faces. After placing the test specimen between the parallel plates of compression device and the spacers on each side, with sufficient clearance for the bulging of the rubber when it is compressed.

Then lubrication is applied, which is then coating of lubrication, having mainly no action on the rubber. In most cases it is silicon or fluorosilicon fluid is used. Tighten the bolt until they comes contact with spacers. The compression load applied the specimen is approximately 25%. Device used to facillite assembling and disassembling the test fixture are mechanical or hydraulic nature. Time and temperature maintain as per the standard ISO23529. Time period for test is suggested are 22h and 70h. The test specimen shall be at room temperature when inserted in the device. And then place assembled compression device in the oven for 2h after completion of assemble and permit it to remain there for the needed test period in dry air at the test temperature selected.

5.5 calculations



$$CA=\frac{h0-h2}{h0-h1}\times 100$$

1) ho= 3 2) h1= 2 3) h2= 2.8

$$CA=\frac{3-2.8}{3-2}\times 100$$

CA= 20%

6 .ANASYS RESULTS

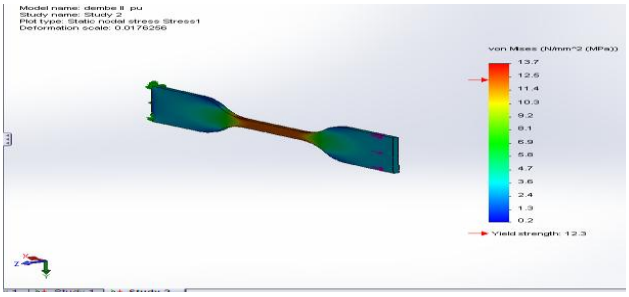


Fig 6.1- 152N load applied and in thr right side we get maximum von-mises 13.7MPA stress result

For maximum force what we got during tensile test calculation result, we get maximum von-mises stress for 152N load is 13.7MPA which as shown in above fig 6.1.

Table 6.1- Anasys results for different loading conditions

Load (N)	Nitrile anasys results for different loading condition
25	2.2
50	4.5
75	6.7
100	9
150	13.5
152	13.7

Table6.2 – Mechanical properties of NBR material

Material	Young's modulus (N/mm^2)	Passions ratio	Tensile strength (N/mm^2)
NBR	1.15	0.48	12.6

7 .HYADULIC TEST

7.1 Hydraulic filter

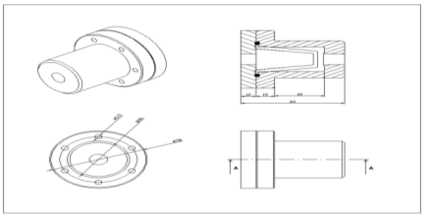


Fig7.1 – 2d drawing of hydraulic filter

These filters are highly dense pressure line filters, which is ideal for applications in simpler hydraulic systems. It provides steadfast fortification from dirt to sensitive apparatus of the system. Due to use of a sintered bronze filter cartridge, it offers absolute filtration.

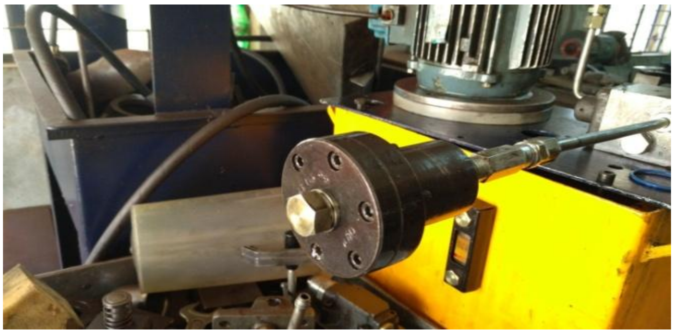


Fig 7.2- hydraulic filter

The filter's corpse and wrap are prepared of high strength casting. The elements of filtration are available in 10, 25 and 75 micro rating correspondingly. By pass valve is provided to prevent any contamination in advance entry into the system. The maximum working pressure is allowed is 140 bar and capacity is 20LPM.

7.2 Hydraulic circuit for test set-up

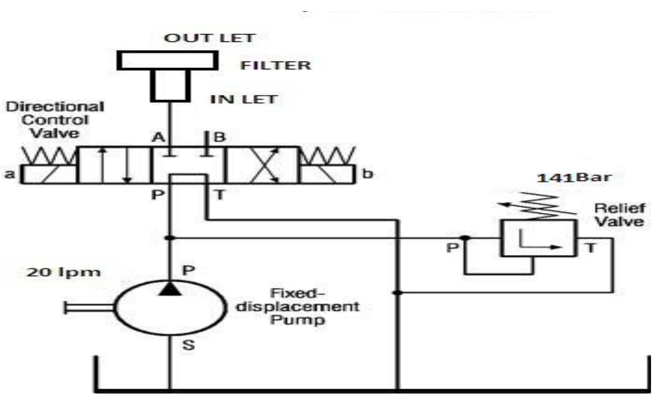


Fig 7.3- hydraulic circuit for test stand

Above fig shows that syematic dia of hydraulic circuit of test stand. As we start the electrical motor oil start pumping from fixed displacement pump, which rotate at 1440rpm. The pump coupled with electrical motor. The oil pump delieverys oil at 20LPM and relief valve level is set to 140 bar, once the pressure in the system exceeeds 140 bar the oil is released to the tank without creating any harm to the system. For testing of the filter the out let is pluged and the inlet of the filter is connected to the A port, and once actuate the directional control valve A the oil pumps from P to A . and once the pressure in system reaches 140 bar the relief valve relase the oil to the tank .

Fig 7.4- Nitrile material seal in filter

1) Experimental pressure- 140bar 2) Experimental hours-500hrs

Experiment carried away on Nitrile material seal under predetermine pressure, there is leakage in filter after sum working hours as seal. During the experiment it shows that Nitrile seal gets fail even before normal experimental working hours which is 500hrs.

8. COMPARISION RESULTS

Table 8.1- Comparison of calculated results with ANSYS results-

Load (N)	Calculated results(MPA)	Tensile anasys results(MPA)
S25	2.016129	2.2
S50	4.032258	4.5
S100	8.064516	6.7
S125	10.08065	9.0
S150	12.09677	13.5
S152	12.25806	13.7

8.1 Hand calculation

$$\text{Stress} = \frac{\text{force}}{\text{area}}$$

9. CONCULSION

NBR material is used in industries for different application purposes. After conducting a experiment like tensile test (distractive), compression(non-distractive) and hardness test on NBR material with considering there mechanical properties, we found that NBR could not resist high pressure and temperature. During physical study NBR material seal in hydraulic filter, with high pressure,. While material seal put inside the filter for high pressure for 500hr, NBR failed in the test, it cannot last longer.