A High level Summary of Environmental Oils used for Oil swelling elastomers. Ref: RP/2014 Eng. Feb-001

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Look at the effects Biological Vegetable Oils have on the swelling of Oil swelling elastomers.

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The Effects of Environmental Biological Vegetable Oils on Oil swelling Elastomers.

Content

Pre-Amble

Swelling Elastomers based around Hydrocarbon Oil swelling have been around and used for many years both in and out of the Oil Industry. With many different patents for applications spanning tens of years there is a reasonable amount known about these and their performance and characteristics. Their acceptance over that last 5-10 years in the oil industry has in general led to a revolution in thinking and in Equipment designs utilising it. One of the drawbacks with Oil exploration is that in environmentally sensitive areas conventional Oil Swelling equipment can lead to potential pollution problems, additionally in these areas environmentally friendlier oils are often used in things like Oil based Muds.

A customer request was made requesting if we had data on the potential of use of environmental oils for use on swelling seals, and if this was possible. Whilst we extensive data on hydrocarbon swelling for both Oil base Muds and produced well fluids we had not researched the effects of environmentally based Oils on Swelling in any great depth. It was decided and agreed that we would look into the use and effects (if any) of these oils on swelling elastomers and/or visa versa.

1.0 Tests as Conducted

The initial area looked into and studied was initially would swelling occur. However to do this we needed to set up a more detailed project looking into the effects of different types of vegetable Oils on swelling elastomers. This was to answer the simple question of did they have different effects chemically as well as mechanically on the elastomer and lastly what type of elastomer is affected by them and to what degree.

Testing was conducted with various vegetable oils available from normal supermarket shelves. The following oils sorts were tested:- Peanut Oil, Rapeseed Oil, Corn Oil, Olive Oil, Soya Bean Oil, Sunflower Oil.

1.1 Different Oils.

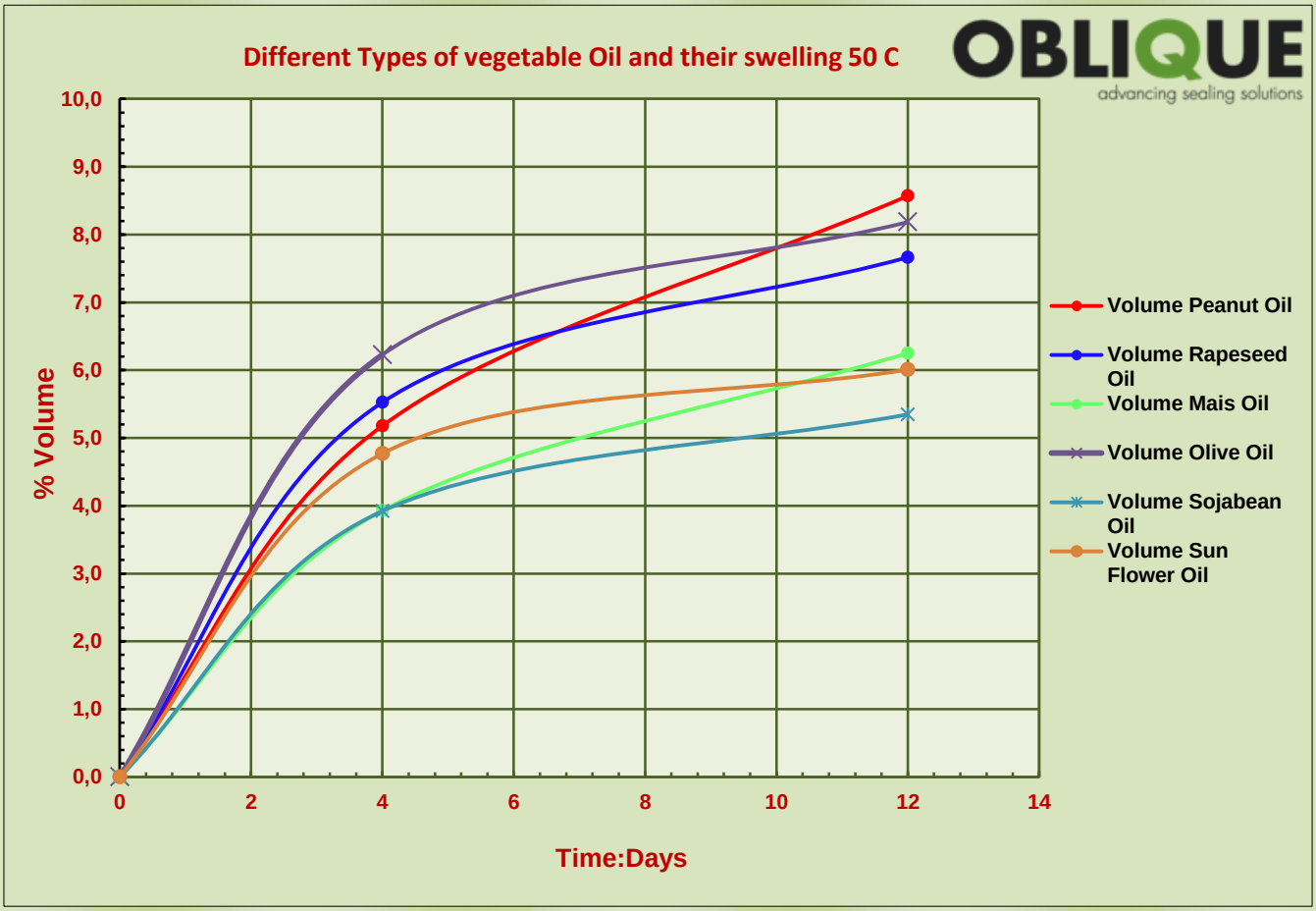

Fig 1

The results of Volume change was plotted (Fig1) and indicated that there was little difference in swelling characteristic in the tested elastomer with the different Oil sorts used. Note that the above is in Volume %. This means on the simple samples of elastomer used that it is the result of length x width x height changes. For height change (thickness) the result above has to be divided by 3. So for the above average swell would be approximately around 7% Volume swell and this would be roughly 2,3% dimensional swell which on a 10mm sample is almost negligible in true dimension swell characteristic.

1.2 Different Elastomers

With the effects of the above in Mind it was not possible to say that swell negligible because of it only being tested on one swell elastomer sort. It was therefore decided that we would test different elastomers to see in how far the elastomer affected the swell.

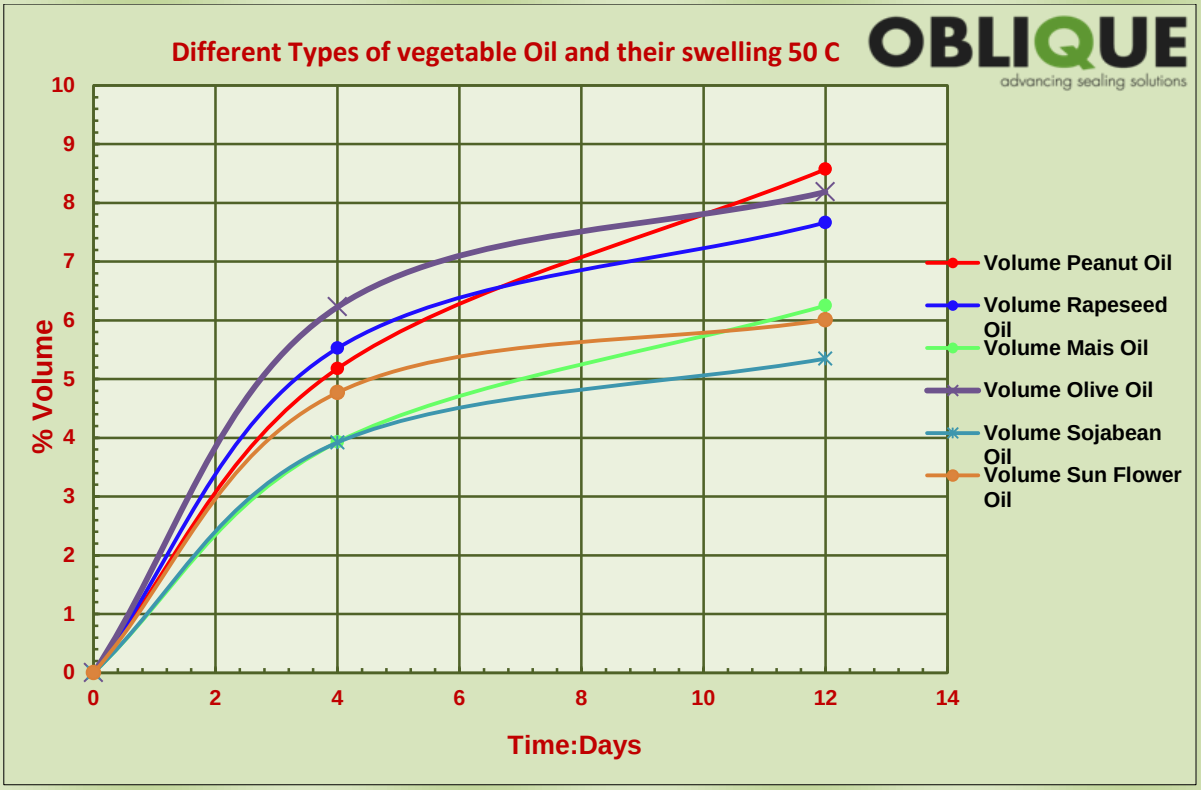

Fig 2. (elastomer type 1)

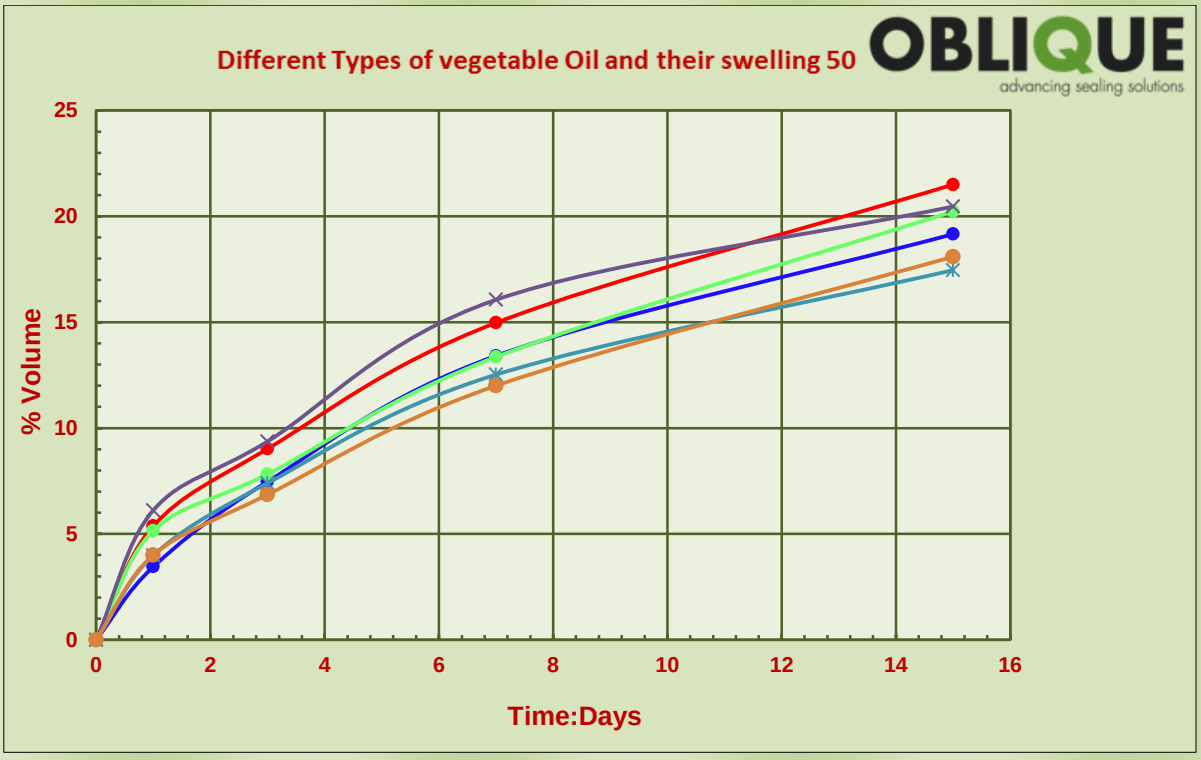

Fig 3 (Elastomer Type 2)

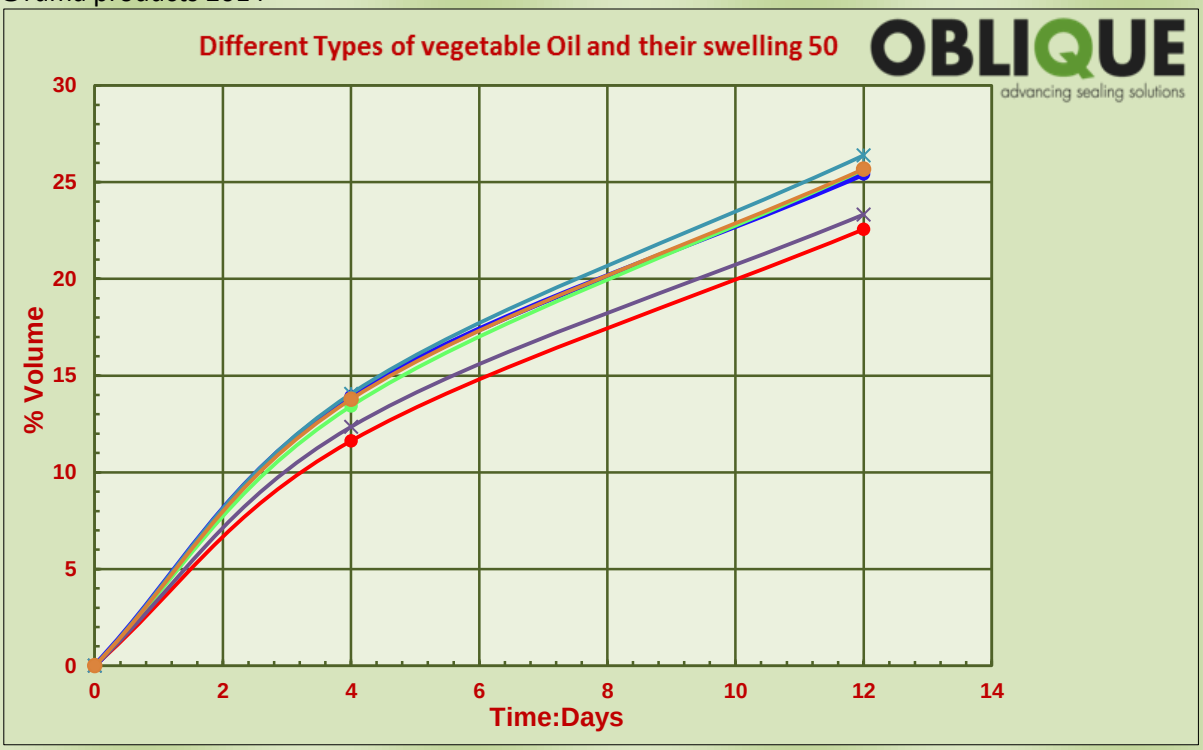

Fig 4 (Elastomer type 3)

With the above results (Fig 4) it is clear that the elastomer choice as well as the temperature is the differentiating factor rather than simply the oil type used.

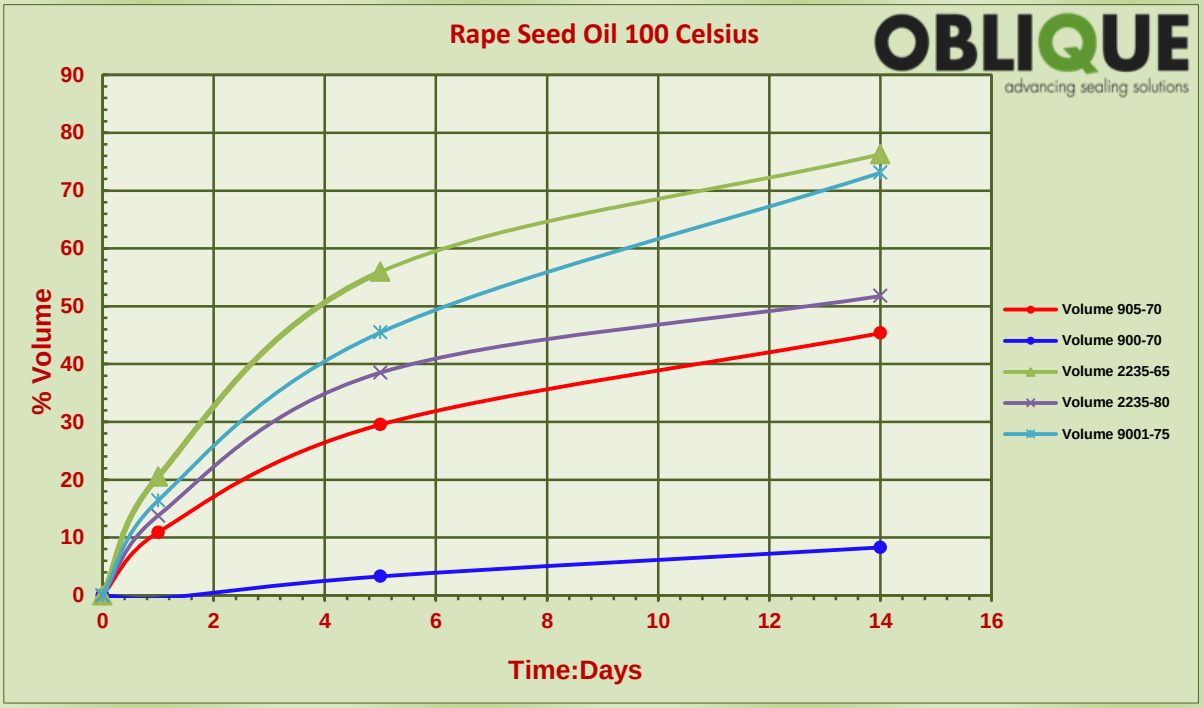

Fig 5 Volume swell Different elastomer types Constant Oil and temperature

2.0 Results

All of the original tests above (Fig 1 to 5) were conducted to understand if there was swell possible and to what degree this was influenced this with different vegetable type oils, and if so how much effect this had on the different elastomer sorts. It was clear that basically no real difference was apparent for the different oil sorts and that their effect was predominantly for different elastomer sorts.

2.1 Graph Plate Thickness Change Center (mm)

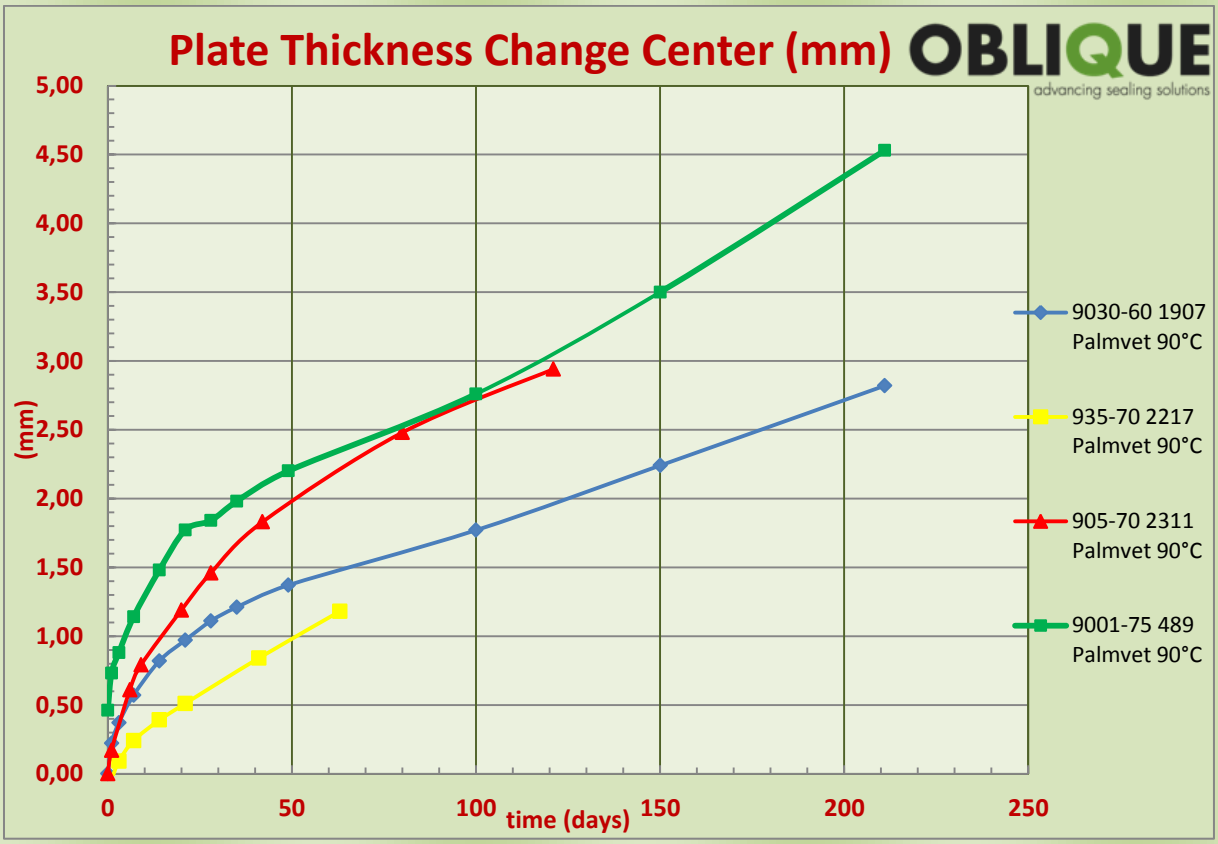

Fig 6

Discussions with various parties active in Oil Field Operations indicated that Palm Oil was the most commonly used environmental oil sort in general use in the Oil and Gas Industry. A new series of tests were therefore started where different Elastomer types specially formulated for swelling with this test were checked for their swell ability in Palm Oil at 90 Celsius. In the above (Fig 6) because volume swell is not the real criteria for swell design we reverted to our standard samples of Elastomer bonded on Steel plate. We were then able to use this and with this the actual thickness increase measured over time. One thing that is immediately apparent is the extreme time required even at high temperature to obtain any form of effective swelling. This is independent of with which different Elastomer types swell was measured against. Even in the most effective elastomer 9001-75 while still continuing to swell the swell is practise extremely slow. In mineral Oil swelling the swell plateau which is depend upon various factor does however tend to have reached an effective end peak after 20-30 days.

2.2 Plate Thickness Change Edge (mm)

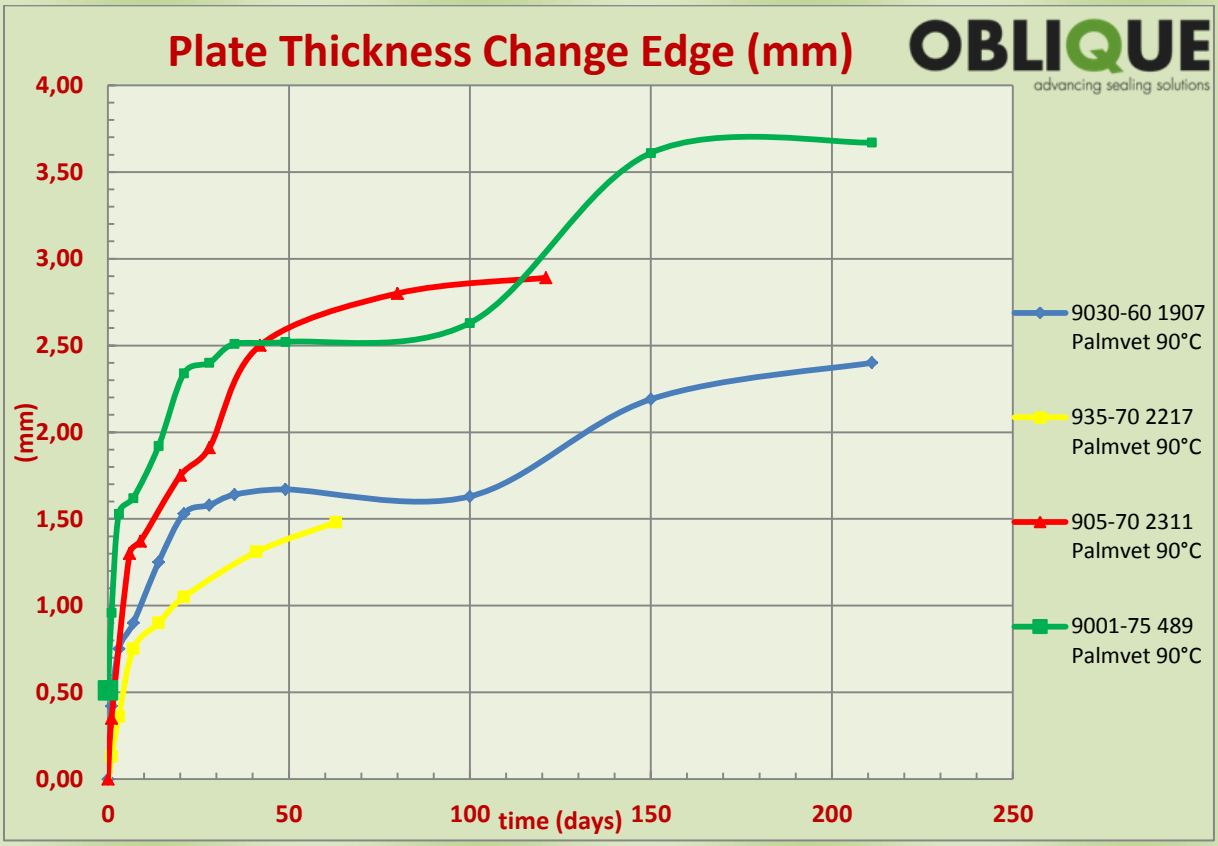

Fig 7

In the above it can clearly be seen that in the intitial phase swelling at the edge is quicker (as would be expeceted) than in the center but this plateaus and swell effectively stops as the elastomer starts to deform and spreads out. Resulting in it starting to gather swell length rather than swell height.

2.3 Change in Hardness due to Swelling and Time

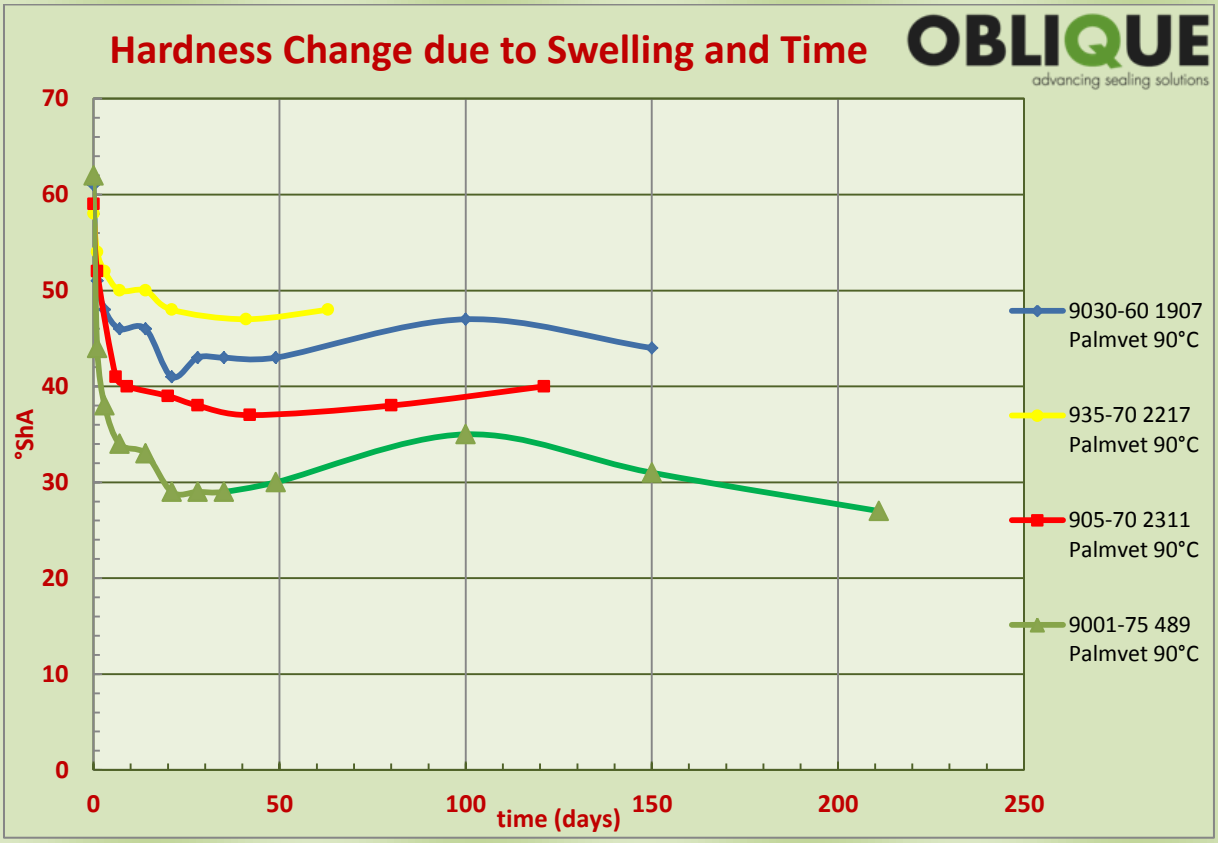

Fig 8

One important criteria and measurement for seal design is the change in hardness with time and how this alters to affect not only the seal but the dissolving of the elastomer. Poor elastomers for that oil will effectively dissolve away with time.

3.0 Conclusions

A number of conclusions can be drawn from the test results obtained:-

- The results obtained were NOT based upon a few days testing but from a Test program that ran for a number of years, with a considerable amount of research NOT reflected in this high level summary report.
- Swelling in Vegetable Oils is feasible.
- Swelling is very much more linked to the correct elastomer design than to the Oil sort used.
- In General environmentally based oil swelling appears to be very much slower than what would happen in conventional Oil swelling elastomers and swelling takes place over a much longer period than would with conventional oil swell.
- Absolute swell is very much reduced compared to existing Oil Swelling elastomers.
- Speed of Environmental Oil swell makes the present generation of equipment as used in the Oil and Gas industry not viable in its present form to be fitted with this elastomer.

4.0 Recommendations

The principle of environmental friendly Oil Swelling Elastomer is proven, although the performance is in terms of swelling is poor . It would require considerably more research into the aspects of swelling performance to substantially improve things. At the moment the demand from the market is insufficient to warrant more work to improve performance and to test, model and improve pressure containing capacity of these swollen seals.

5.0 Authorisation

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