Volume change test optimisation, water displacement method versus the photographic method

Nadia Luijsterburg-Vleugels, Hans van der Meer, Gözde Tuzcu, and Jaap Havinga

Introduction

ISO 1817 *Rubber, vulcanized or thermoplastic - Determination of the effect of liquids* describes two methods to described the volume change, the traditional water displacement method (WDM) and with help of photographic method (PM), see figure 1. The latter is especially useful when testing is done in extremely volatile liquids or liquified gasses. The main advantage of the PM is the extremely quick capturing of the surface area of the sample after removal from the test vessel. The WDM is much more time consuming having to weigh the sample in both air and water. During this time the test medium keeps evaporating from the sample making the WDM a less suitable method.

Conclusion

The overall conclusion is that this study shows that the traditional WDM is the more robust method compared to the PM when using a non-volatile test liquid. When using the PM there is an underestimation of the results. The PM is a useful method if testing is done in volatile liquids or liquified gasses.

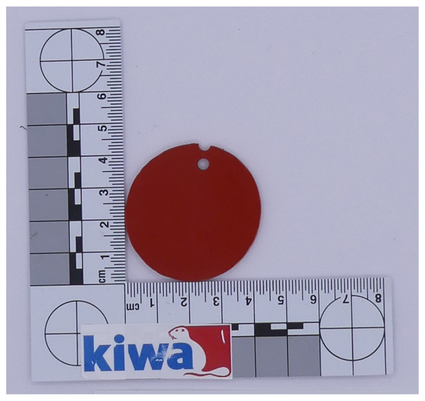

Figure 1. PM sample example.

The water displacement test method is more robust than the photographic test method

Visual inspection using an x-y-plot and the relative Bland-Altman-plot, see figure 2, shows that the PM already from the beginning starts to deviate from the unity line resulting in lower swelling values for PM. The relative Bland-Altman-plot confirms this, because most of the data points lie on the x-y plane and shows also that the largest deviation is visible at low swelling values and the difference is significant

The R^2 value is 99,3% of the regression line confirms that the regression method is valid to use, to explain the variation. The intercept-0,9775, with a confidence interval of 95%-2,954-0,999. The value 0 lies within this interval so there is NO significant difference. The slope 0,9104, with a confidence interval of 95% 1,011-1,057, the value 1 does NOT lie within this interval, meaning that there is a significant deviation from 1. So, it can be concluded that there is a proportional difference between the two methods, where PM results in an underestimation of the test results.

Table 1 shows the average standard deviations of all n-pentane/butyl acetate blends.

In all cases except in the n-pentane on average the WDM is more precise.

The overall conclusion is that the WDM is the more robust method compared to the PM.

	72h (%)		168h (%)	
	WDM	PM	WDM	PM
n-pentane	2,8	2,4	2,4	1,8
20% BA	1,8	2,8	0,8	Unknown*
30% BA	0,7	1,7	1,0	2,7
60% BA	0,7	1,7	0,6	1,5
100% BA	0,3	2,1	0,7	2,0

**was not tested*

Table 1. All average standard deviation overview.

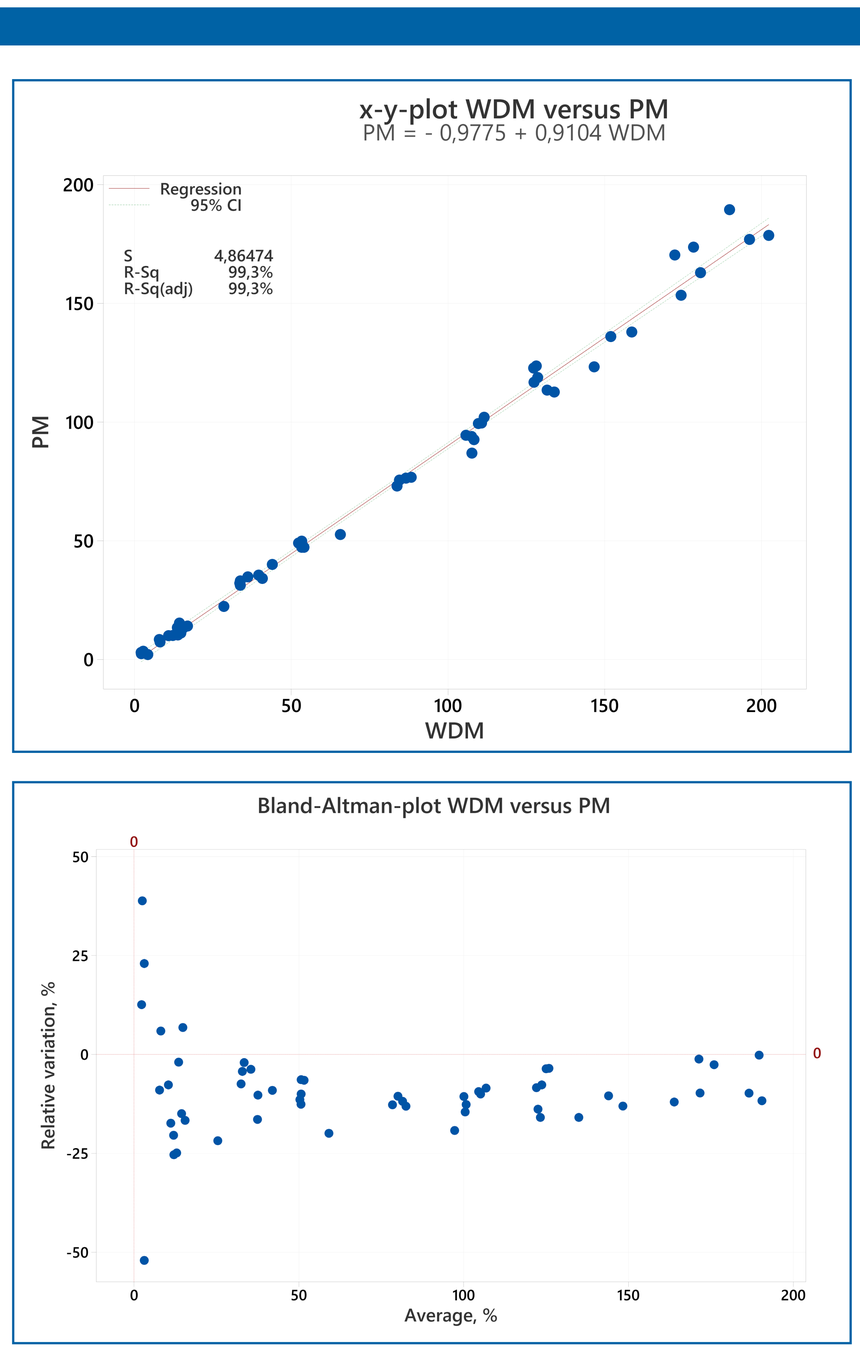

Figure 2. WDM versus PM for all blends and rubbers results together x-y plot (top) and Bland-Altman-plot (bottom)

Safety

Additionally, working with BA (laboratory) has the advantage that is less sensitive for evaporation, it is non-toxic and reasonably easy to obtain for a normal price. Those together explain the preference for n-BA.

Acknowledgement

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Nadia Luijsterburg-Vleugels
Kiwa Technology
Apeldoorn, The Netherlands
Nadia.Luijsterburg-Vleugels@kiwa.com

Hans van der Meer, Gözde Tuzcu and Jaap Havinga
Rijswijk, The Netherlands

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