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THE INFLUENCE OF HUMIDITY ON ABS PLASTIC MEASUREMENT RESULTS

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Abstract

This paper deals with effect of changing humidity in metrology lab during measuring process. Team of researchers simulated different conditions in metrology lab = stabile temperature and different humidity. During experiment CMM Carl Zeiss Prismo was used. The main question was, if there is effect of humidity 30-60% for results of measurement of basic parameters. As tested material team used ABS injection plastic which is the basic mold injection plastic material in automotive industry . The result show and describe effect and importance of stabile conditions in metrology lab and during storage of products.

Keywords: CMM; humidity; laboratory; precision of measurement, ABS plastic

1. Introduction

Although the current social mood of plastics and products from them is not too inclined, it is remaining fact that plastics for their unique features find enormously broad application in all areas of industrial production. In areas such as automotive production, plastics processing is among the priority fields.

The Accredited Metrology Laboratory of Regional Technology Institute, Faculty of Mechanical Engineering, West Bohemian University has been working for long period with industry partners across the whole automotive supply chain. The current IATF automotive standard clearly states that if a manufacturer (automotive) does not want to or cannot carry out some of the measurements required by the customer himself, one of the accredited laboratories within the meaning of standard 17025 must do this measurement.[1], [3]

The accredited metrology laboratory shall always have controlled environment conditions in order to achieve repeatability and reproducibility of its measurement. For the field of temperature, this requirement is quite clear, relevant and now largely implemented in laboratory systems and measurement centres. However, the humidity environment parameter remains a specific chapter. The standard for the CMM 10360-2, however, indicates the reference value of 50±10%, but this is the recommended value for 3D measuring machines and not for the products. This paper describes an experiment in which the impact on precision of measurement outputs of the plastic parts for the automotive industry has been verified in a controlled environment change.

2. Experiment description

The experiment was conducted under controlled conditions at a constant temperature of 20 ± 2 ° C. During the experiment only 1 operator performed measurements to eliminate the reproducibility error. This operator repeatedly measured the selected parameters on samples of ABS plastic part. Selected parameters = Inner diameter, wall thickness, length describe main metrology tasks for ABS evaluation. The measurement itself was performed on the CMM Carl Zeiss Prismo 7 Navigator equipped with a fixed sensor head with an measurement uncertainty of 0.9µL / 350µm.[1], [5], [8] The measurements were carried out gradually at 30%, 45%, 60% humidity. Total of 5 samples of the same test sample being performed at each value due to the relevance of subsequent statistical data processing.

Fig. 1. Tested sample

3. Statistical processing

After obtaining the raw data, these data were mathematically processed in order to create a mathematical description of the influence of ambient humidity on the resulting value of the measurement for the chosen shape parameters. As it is clear from the output, the resulting measurement value changes at 30%, 45%, 60%. The specified mathematical formula may be a useful tool for industrial practice, especially for the situations where measurement does not take place in a controlled environment of a metrology laboratory.[4]

3.1 Parameter length_1_Y

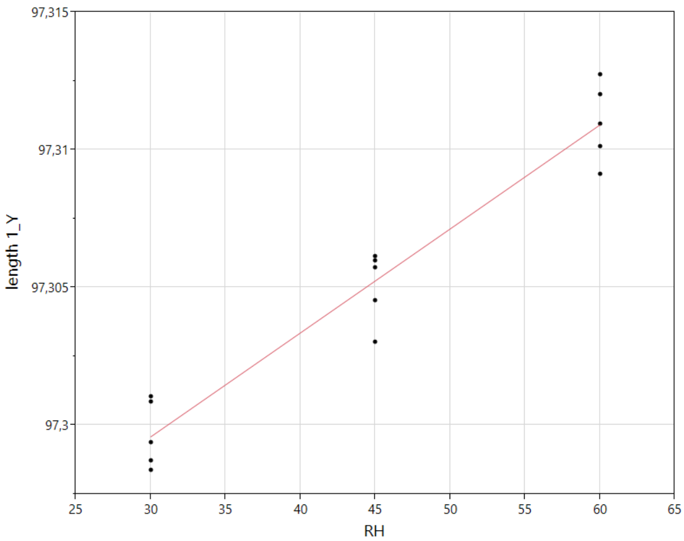

Fig. 2. Chart dependence for length_1Y

Parameter	Value
RSquare	0,937721
RSquareAdj	0,93293
Root Mean Square Error	0,001279
Mean of Response	97,30526
Observations (or Sum Wgts)	15

Table 1. Parameters of dependence for length_1Y

The predictive model of the length dependence of the change of the humidity value RH (1) describes 93.293% of the variability of the studied variable on the basis of the adjusted index of determination (RSquareAdj).[9] Therefore, the model predicts within the moisture interval 30 to 60% with an accuracy of 93.293%, with an average value of the measured quantity being 97.30526.

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob> F
Model	1	0,00032	0,00032	195,7368	<,0001
Error	13	2,13E-05	1,64E-06		
C. Total	14	0,000342			

Table 2. Prediction model for length_1Y

From the ANOVA analysis table, the model used is adequate based on the Fischer-Snedecor test criterion and therefore we can say that at the selected level of significance α = 5%, there is at least one factor (predictor) in the model that varies from zero.

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	97,28827	0,001258	77338	<,0001
RH	0,000377	0,000027	13,99	<,0001

Table 3. Parameters of dependence formula

The table shows that the greatest effect on the change in the value of length 1Y is the absolute intercept. It hides all the neglected factors we have not considered in the experiment. But, at the chosen level of significance α = 5%, the RH moisture value is statistically significant. The model itself can therefore be expressed in the form of:

$$lenght\_1\_Y = 97,28827 + 3,77.10^{-4}.RH$$

3.2. Parameter wall-thickness

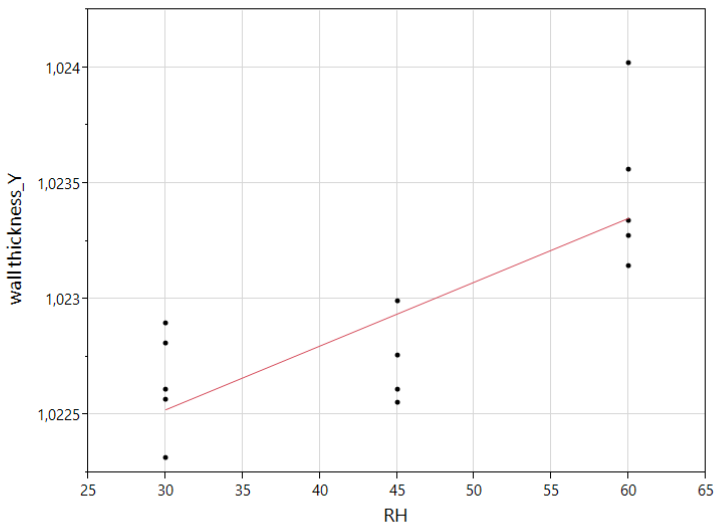

Fig. 3. Chart dependence for wall-thickness

The essence is the same as in the first case.

RSquare	**0,585348**
RSquareAdj	0,553452
Root Mean Square Error	0,000305
Mean of Response	1,022937
Observations (or Sum Wgts)	15

Table 4. Parameters for wall-thickness

Source	DF	Sum of Squares	MeanSquare	F Ratio	Prob> F
Model	1	1,71E-06	1,71E-06	18,3516	0,0009
Error	13	1,21E-06	9,32E-08		
C. Total	14	2,92E-06			

Table 5. Prediction model for wall-thickness

Term		Estimate	StdError	t Ratio	Prob>|t|
Intercept		1,021696	0,0003	3403	<,0001
RH		2,76E-05	6,44E-06	4,28	0,0009

Table 6. Parameters of dependence formula

$$thnickness = 1,021696 + 2,76.10^{-5}.RH$$

3.3. Inner diameter

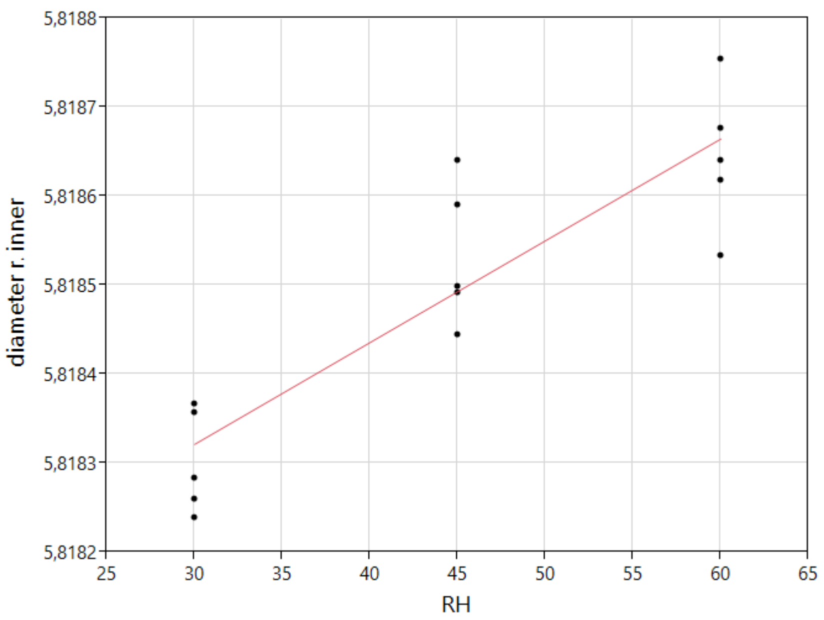

Fig. 4. Chart dependence for Inner diameter

RSquare	**0,792845**
RSquareAdj	0,77691
RootMeanSquareError	0,000077
Mean of Response	5,818493
Observations (or SumWgts)	15

Table 7. Parameters for Inner diameter

Source	DF	Sum of Squares	MeanSquare	F Ratio	Prob> F
Model	1	2,94E-07	2,94E-07	49,755	<,0001
Error	13	7,69E-08	5,92E-09		
C. Total	14	3,71E-07			

Table 8. Prediction model for Inner diameter

Term		Estimate	StdError	t Ratio	Prob>|t|
Intercept		5,817978	7,56E-05	76933	<,0001
RH		1,14E-05	1,62E-06	7,05	<,0001

Table 9. Parameters of dependence formula

$$diameter = 5{,}817978+1{,}14.10^{-5}.RH$$

4. Conclusion

The article deals with one of the often overlooked influences when measuring plastic parts - environmental humidity. As part of the experiment in an accredited laboratory, the selected parameters were repeatedly measured on samples made from ABS plastic. These measurements were carried out at constant humidity levels of 30%, 45%, 60%. The results obtained during experiment were mathematically processed and for the main parameters (length, thickness, inner diameter) the mathematical dependences were found. The formulas that describes the behaviour of controlled parameters when changing the humidity of the environment and may be a useful tool for industrial practice where measurement uncertainty is not determined, but the moisture parameter must be taken into account.

As the future plan of the experiment team will test behaviour of different materials, under the same conditions as described in this paper. The final goal is to create manual for metrology of the basic materials in the field of automotive and aerospace industry.

5. Acknowledgments

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