11th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2007, Hammamet, Tunisia, 05-09 September, 2007.

POSSIBILITIES OF PARAMETER ADJUSTMENT DURING VULCANIZATION

Igor Suba
Matador Automotive, Továrenská 1. P.O. Box 80, 018 41 Dubnica nad Váhom, Slovakia,
E-mail: igor. suba@matador.automotive.sk

Ivan Letko, Jana Kucerova
Faculty of Industrial Technologies
I. Krasku 491/30, 020 01 Puchov
Slovakia

ABSTRACT
At final parameters and characteristics of tyre can influence several basic elements – tyre composition, sort of used fillers, caoutchouc, reinforcing materials, their construction, choice of curing process, process of stabilization, storage conditions and so on.
Nowadays by motorizing development are producers specialized for tire properties parameterize.
This fact is necessary to satisfy the improving subtlety of requirements on tyre component properties, not only in dependence of season but also its region, car model, car axle type, case of axle suspension and last but not least especially customers requirements.
Ways to satisfy requirements are various and consequently different costly. They lead from basic research of raw materials and its combination, through the most often applied research and chemism development to the economize case – parameters configuring of curing process.
The work deals with find out the dependency between parameter differences of vulcanization process and final dimensional – deformation tyre parameters.
Keywords: vulcanization process, thermal measurement, vulcanizates

1. INTRODUCTION
Vulcanization is defined as a chemical process, during which it comes to creation of chemical cross-links among rubber chains under actuating the components of vulcanization system and temperature [1]. Concentration of components the vulcanization system gradually decreases almost to the zero value. During vulcanization the linear structure on rubber chains changes to space structure and rubber goes through plastic to elastic state. Vulcanizate is characterized especially by a high reversible deformation at a rather low level of elasticity module, which relates specially to creating space structure of vulcanizates [2, 3, 4]. This process is very important for the next treatment properties of vulcanizates. Tire cut as a composite system is seen on figure 1.

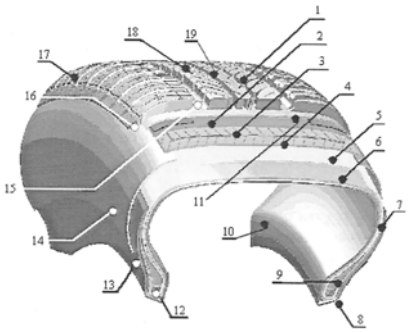


Figure 1. Decomposition of basic elements and reinforcing materials in passenger radial tyre: 1. block of pattern, 2. cap ply, 3. breaker No.2, 4. breaker No.1, 5. carcass ply No.2, 6. carcass ply No.1, 7. winding-up of carcass ply, 8. bead, 9. apex, 10. inner liner, 11. undertread, 12. bead wire, 13. field of bead, 14. sidewall, 15. tread groove, 16. tread wing, 17. shoulder, 18. tread, 19. tread rib

2. EXPERIMENTAL PART

2.1. Thermal data measurement

It is measurement of heat passage during vulcanization process in specific points of tyre by measurement equipment ALMEMO 5590-2. Transfer thermal data from vulcanized tyre to the memory of measurement equipment was realized by calibrated thermo elements type TT-K-30, which were installed to the tyre in short time before vulcanization /see figure 2/ [5, 6].

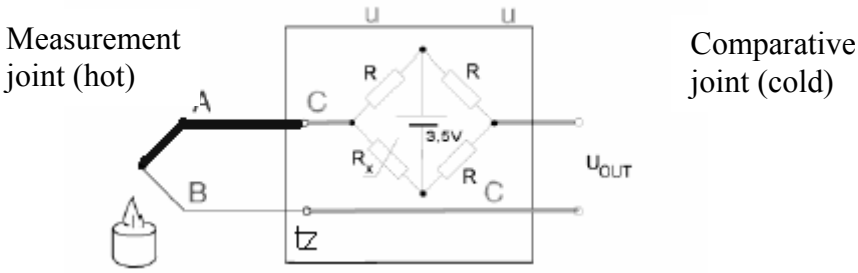


Figure 2. Calibrated thermo elements type TT-K-30.

2.2. Aramis measurement system

It is very simple way to measurement of tyre deformation. We detect deformation in dependence on rotation speed of booted tyre at define speed. For visualisation the loaded object, it is used one CCD camera (for 2D measuring field) or 2 cameras (for 3D deformation). Pattern is in high contrast with tyre surface. There are used digital analyses and correlative methods, deforming of pattern and tension are enumerated automatically by change the pattern of tested surface, which is seen on figures 3 and 4.

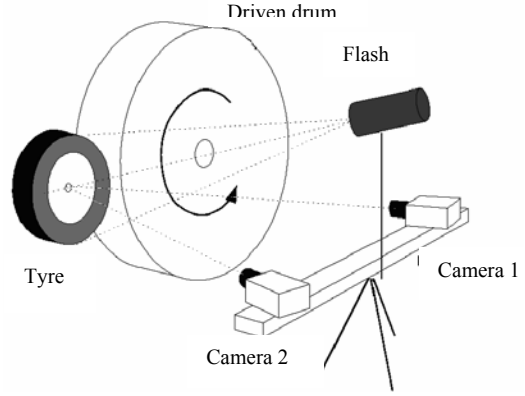


Figure 3. Mode of operation the Aramis 3D.

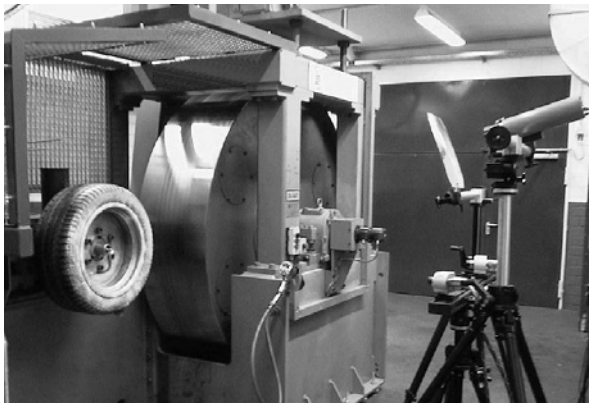
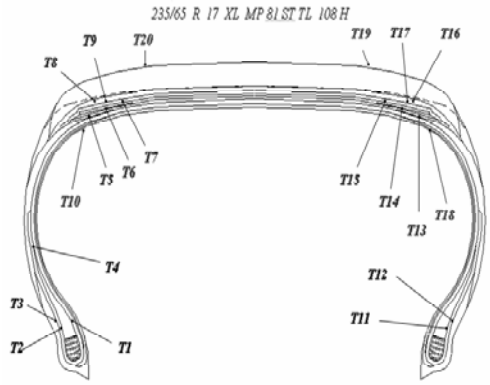


Figure 4. Real shot of measurement dimensional deformation characteristic.



Bead zone:
T1 – on carcass ply No. 2 under apex from bladder (0,5 cm over wire)
T2 – on apex under carcass ply No. 2 from mould (0,5 cm over wire)
T3 – between carcass plies No. 1 and No. 2 from mould (0,5 cm over wire)
T4 – on carcass ply No. 2 under sidewall in the middle over wind-up of carcass ply No.1
T9 – on cap ply under tread (0,5 cm from thermocouple T8)
Shoulder zone:
T5 – on carcass ply No. 2 under steel cord breaker No. 1
T6 – between steel cord breakers No. 1 and No. 2 (on edging strip)
T7 – on steel cord breaker No. 2 under the cap ply
T8 – on cap ply under tread
Surfaces zone:
T10 – on inner liner

Figure 5. Thermoelement´s spacing.

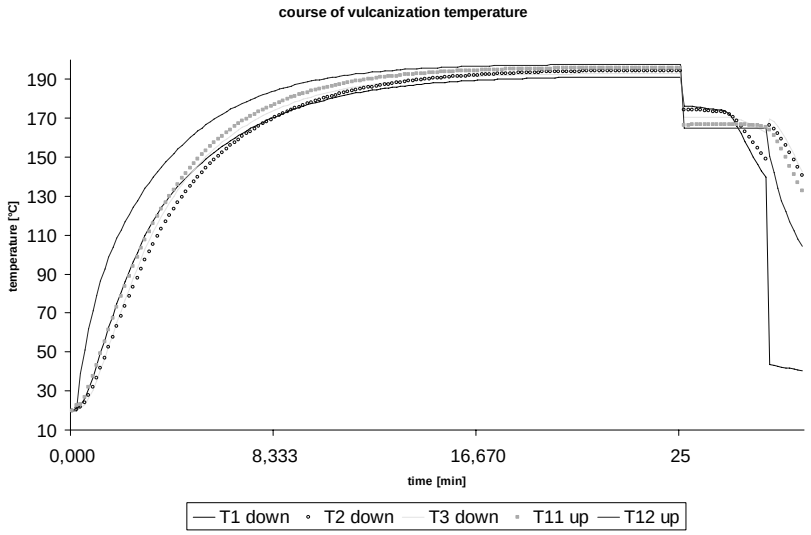


Figure 6. Results of tire marked 235/65/R17 XL MP81.

Figure 5 describe the spacing of individual thermoelements which are common in tire. The places of T1-T3 and T11, T12 are characteristic for bead area. Results of temperature – time dependence of these areas are on figure6.

Result of Aramis measurement system is display on next figure 7.

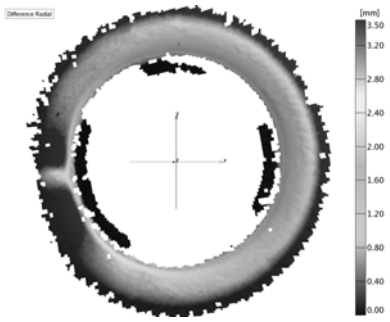


Figure 7. Results of Aramis apparatus

3. CONCLUSION

Consequence of this experimental work is confirmed or confute hypothesis about dependence of change vulcanization process parameters on final dimensional deformation characteristic of tyre by comparing deformation during measurements on ARAMIS.

4. REFERENCES

[1] Prekop Š.a kol.: Gumárenské technológie II,1.vydanie, GC TECH s TnU AD v Trenčíne, 2003.
[2] Marcin, J.: Pneumatiky, STNL Praha 1985.
[3] Ducháček, V.: Gumárenské suroviny a jejich spracováni. VŠCHT Praha 1990, s. 22-31.
[4] Bafrnec, M.; Toman, J.: Stanovenie fyzikálnych vlastností gumárenských zmesí pre matematické modelovanie vulkanizácie, Department of Chemical and Biochemical Engineering, Slovak University of Technology, Bratislava, 2000.
[5] Zehnula, K.: Snímače neelektrických veličín. SNTL, PRAHA 1977.
[6] Petrovič, J.: Automatizácia v priemysle – meranie. Alfa Bratislava, 1981.
[7] Langfelder, I.: Procesy a zariadenia I., Alfa – SNTL, Praha 1987.
[8] Tire mold and method of rapidly depressurizing the mold. Inventors: Ciesa, Clifford Jack. USP 838623.2001-04-19.