

## Referências Bibliográficas

- [1] Atapattu, D. D.; Chhabra, R. P.; Uhlherr, P. H. T. Creeping sphere motion in Herschel-Bulkley fluids: flow field and drag. *Journal of non-Newtonian Fluid Mechanics*, 59:245–265, 1995.
- [2] Barletta, A. Fully developed laminar forced convection in circular ducts for power-law fluids with viscous dissipation. *International Journal of Heat and Mass Transfer*, 40:15–26, 1997.
- [3] Benedict, R. P. **Fundamentals of Temperature, Pressure and Flow Measurements**. John Wiley Sons Inc., USA, 3rd edition, 1984.
- [4] Bird, R. B.; Armstrong, R. C.; Hassager, O. **Dynamics of Polymeric Liquids**, volumen 1. John Wiley Sons Inc., USA, 2nd edition, 1987.
- [5] Carreau, P. J.; Kee, D. C. R. De; Chhabra, R. P. **Rheology of Polymeric Systems - Principles and Applications**, volumen -. Hanser/Gardner Publications, USA, - edition, 1997.
- [6] Chhabra, R. P.; Richardson, J. F. **Non-Newtonian Flow in the Process Industries**. Butterworth Heinemann, Great Britain, 1st edition, 1999.
- [7] Choi, S. U. S.; Cho, Y. I.; Kasza, K. E. Degradation effects of dilute polymer solutions on turbulent friction and heat transfer behavior. *Journal of Non-Newtonian Fluid Mechanics*, 41:289–307, 1992.
- [8] Farias, M. H.; Mendes, P. R. S.; Vinagre, H. M. Characterization of viscoplastic materials with rotating vane and bob rheometry. *Proceedings of COBEM 2003*, 17th International Congress of Mechanical Engineering, (in CD-ROM), -:-, 2003.
- [9] Fox, R. W.; McDonald, A. T. **Introdução à Mecânica dos Fluidos**, volumen -. LTC, Rio de Janeiro, BR, 4 edition, 1998.
- [10] Holman, J. P. **Experimental Methods for Engineers**. McGraw-Hill, USA, 6th - international edition edition, 1994.

- [11] Incropera, F. P.; Dewitt, D. P. **Fundamentos de Transferência de Calor e Massa**, volumen -. LTC, Rio de Janeiro, BR, 3 edition, 1992.
- [12] Joshi, S. D.; Bergles, A. E. **Analytical study of Heat Transfer to Laminar in Tube Flow of Non-Newtonian Fluids**. The American Institute of Chemical Engineers, 76:270–281, 1980.
- [13] Khatyr, R.; Ouldhadda, D.; Idrissi, A. II. **Viscous dissipation effects no the asymptotic behavior of laminar forced convection for Bingham plastics in circular ducts**. International journal of Heat and Mass Transfer, 46:589–598, 2003.
- [14] Khellaf, K.; Lauriat, G. **Numerical study of heat transfer in a non-Newtonian Carreau-fluid between rotating concentric vertical cylinders**. Journal of Non-Newtonian Fluid Mechanics, 89:45–61, 2000.
- [15] Kozicki, W.; Chou, C. H.; Tiu, C. **Non-newtonian flow in ducts of arbitrary cross-sectional shape**. Chemical Engineering Science, 21:665–679, 1966.
- [16] Lee, D.; Irvine, T. F. **Shear Rate Dependent Thermal Conductivity Measurements of Non-Newtonian Fluids**. Experimental Thermal and Fluid Science, 15:16–24, 1997.
- [17] Loulou, T.; Peerhossaini, H.; Bardon, J. P. **Etude experimentale de la conductivité thermique de fluids non-Newtoniens sous cisaillement application aux solutions de Carbopol 940**. International Journal of Heat and Mass Transfer, 35:2557–2562, 1992.
- [18] Manglik, R. M.; Fang, P. P. **Effects of eccentricity and thermal boundary conditions on laminar fully developed flow in annular ducts**. International Journal of Heat and Fluid Flow, 16:298–306, 1995.
- [19] Manglik, R. M.; Fang, P. **Thermal processing of viscous non Newtonian fluids in annular ducts: effects of power-law rheology, duct eccentricity, and thermal boundary conditions**. International Journal of Heat and Mass Transfer, 45:803–814, 1995.
- [20] Mizuna, T.; Ito, R.; Kuriwake, Y.; Yahikawa, K. *Kagaku Kogaku*, 31:250, 1967.
- [21] Naimi, M.; Devienne, R.; Lebouché, M. **Etude dynamique de l’écoulement de Couette-Taylor-Poiseuille; cas d’un fluide**

- présentant un seuil d'écoulement. *International Journal of Heat and Mass Transfer*, 33:381–391, 1990.
- [22] Nascimento, U. C. S.; Macêdo, E. N.; Quaresma, J. N. N. Thermal entry region analysis through the finite integral transform technique in laminar flow of Bingham fluids within concentric annular ducts. *International Journal of Heat and Mass Transfer*, 45:923–929, 2002.
- [23] Nouar, C.; Lebouché, M.; Devienne, R.; Riou, C. Numerical analysis of the thermal convection for Herschel-Bulkley fluids. *International Journal of Heat and Mass Transfer*, 16:223–232, 1995.
- [24] Nouar, C.; Desaubry, R.; Zenaidi, H. Numerical and experimental investigation of thermal convection for a thermodependent Herschel-Bulkley fluid in an annular duct with rotating inner cylinder. *European Journal of Mechanics - B/Fluids*, 17:875–900, 1998.
- [25] Nouar, C.; Benaouda-Zouaoui, B.; Desaubry, C. Laminar mixed convection in a horizontal annular duct. Case of thermodependent non-Newtonian fluid. *European Journal of Mechanics - B/Fluids*, 19:423–452, 2000.
- [26] Papanastasiou, T. C. Flow of materials with yield. *Journal of Rheology*, 31:385–404, 1987.
- [27] Park, N. A.; Irvine, T. F. Anomalous viscosity-temperature behavior of aqueous Carbopol solutions. *Journal of Rheology*, 41(1):167–173, 1997.
- [28] Rohsenow, W. M.; Hartnett, J. P.; Cho, Y. I. *Hanbook of Heat Transfer*, volumen -. McGraw-Hill, United States of America, 3rd edition, 1998.
- [29] Sayed-Ahmed, M. E. Forced Convection Heat Transfer of a Robertson-Stiff Fluid Between Two Coaxial Rotating Cylinders. *Int. Comm. Heat Mass Transfer*, 26:695–704, 1999.
- [30] Scirocco, V.; Devienne, R.; Lebouche, M. Ecoulement laminaire et transfert de chaleur pour un fluide pseudo-plastique dans la zone d'entrée d'un tube. *International Journal of Heat and Mass Transfer*, 28:91–99, 1985.

- [31] Shin, S. **The effect of the Shear Rate-Dependent Thermal Conductivity of Non-Newtonian Fluids on the Heat Transfer in a Pipe Flow.** International Comm. Heat Mass Transfer, 23:665–678, 1996.
- [32] Sieder, E. N.; Tate, G. E. **Heat transfer and pressure drop of liquids in tubes.** Industrial and Engineering Chemistry, 28:1429–1435, 1936.
- [33] Mendes, P. R. S.; Dutra, E. S. S. **Viscosity function for yield stress liquids.** Applied Rheology, 2004.
- [34] Soares, M.; Naccache, M. F.; Mendes, P. R. S. **Heat transfer to viscoplastic liquids flowing laminarly in the entrance region of tubes.** International Journal of Heat and Fluid Flow, 20:60–67, 1999.
- [35] Soares, E. J. **Transferência de Calor em escoamento Laminar de Materiais Viscoplásticos através de Espaços anulares.** PhD thesis, Pontifícia Universidade Católica do Rio de Janeiro - PUC-RJ, Rio de Janeiro, RJ, 1999. Dissertação de Mestrado.
- [36] Soares, E. J.; Naccache, M. F.; Mendes, P. R. Souza. **Heat transfer to viscoplastic materials flowing axially through concentric annuli.** International Journal of Heat and Fluid Flow, 24:762–773, 2003.
- [37] Vradis, G. C.; Dougher, J.; Kumar, S. **Entrance pipe flow and heat transfer for a Bingham plastic.** International Journal of Heat and Mass Transfer, 36:543–552, 1993.
- [38] Wichterle, K. **Heat Transfer in temperature-dependent non Newtonian flow.** Chemical Engineering and Processing, 43:1223–1230, 2004.

# **A**

## **Apêndice**

### **A.1**

#### **Evolução das Temperaturas ao Longo do Tempo nos Testes em Espaços Anulares**

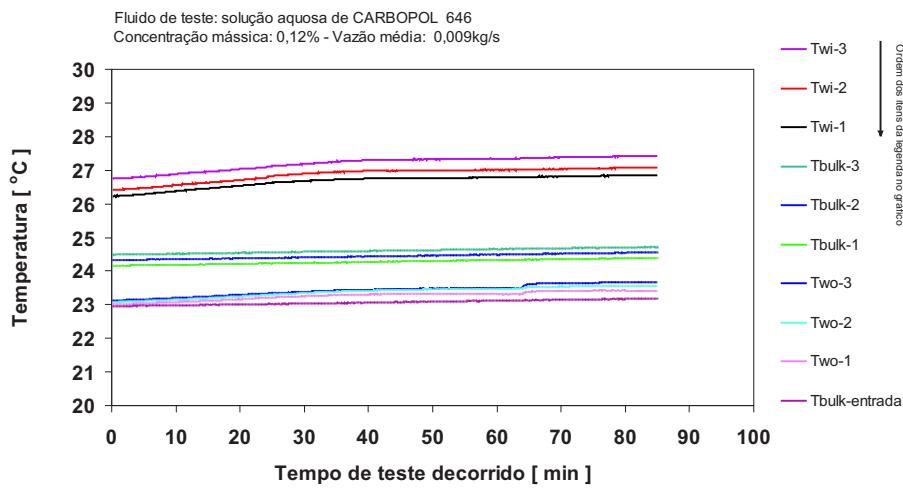


Figura A.1: fluxo de calor:  $202,18 \text{ W/m}^2$ ,  $R_i/R_o = 0,33$

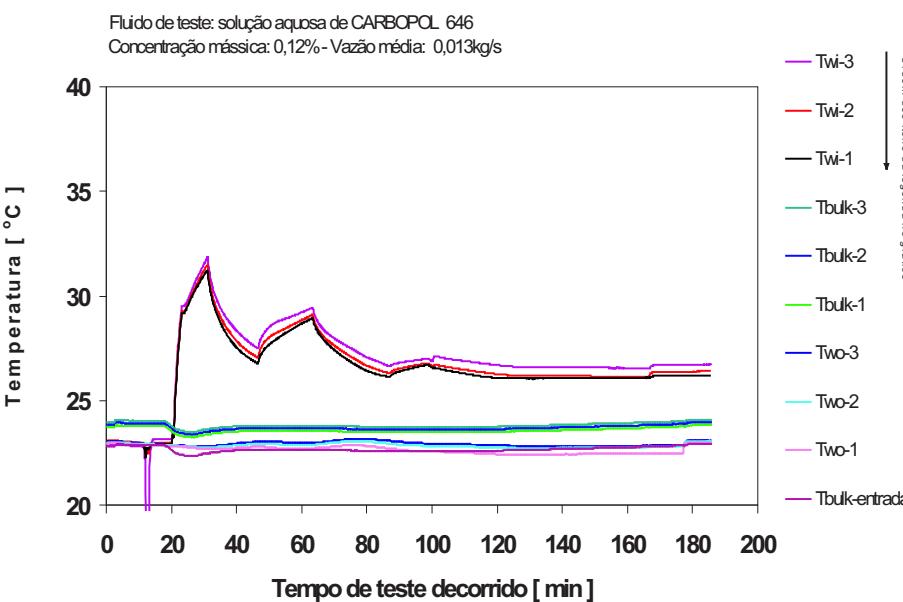
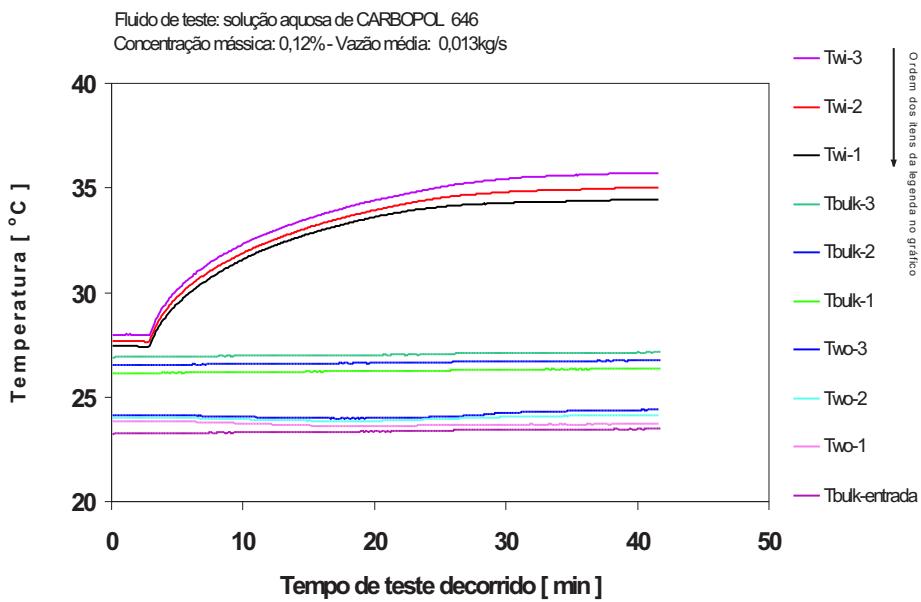
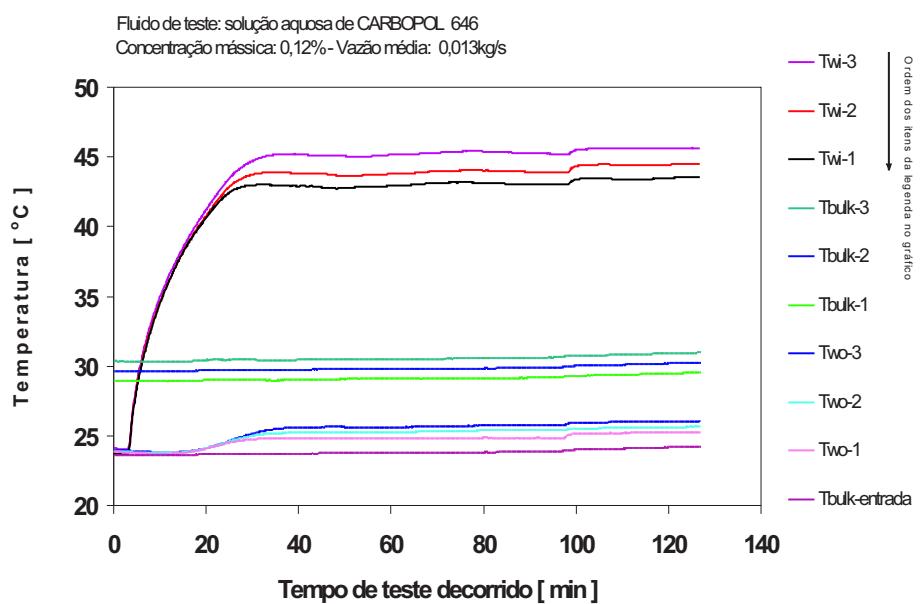
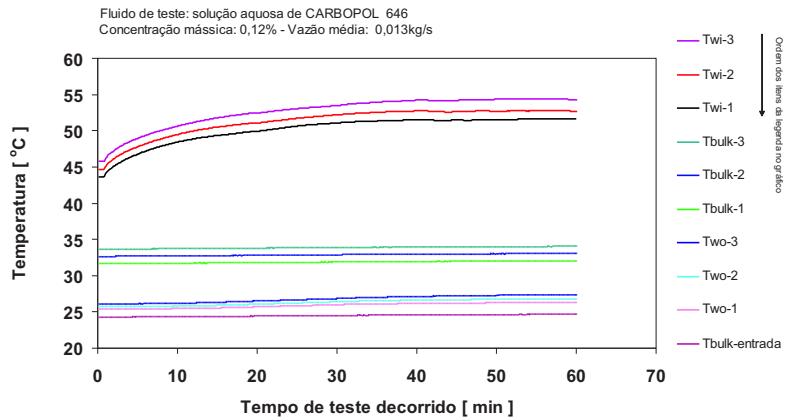
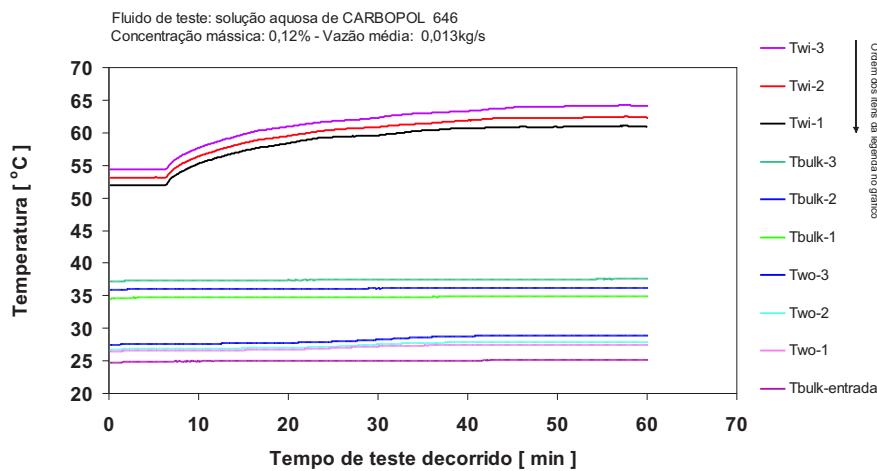
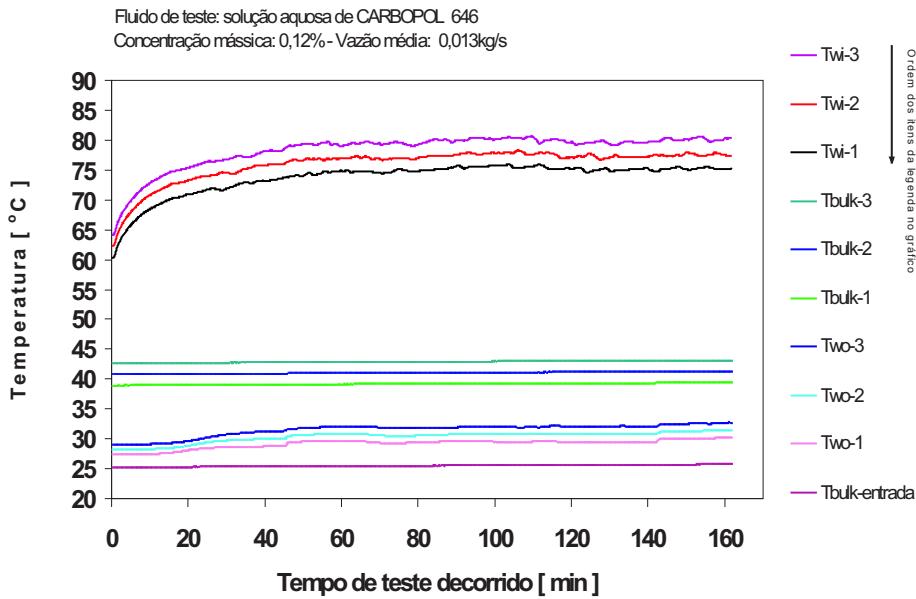
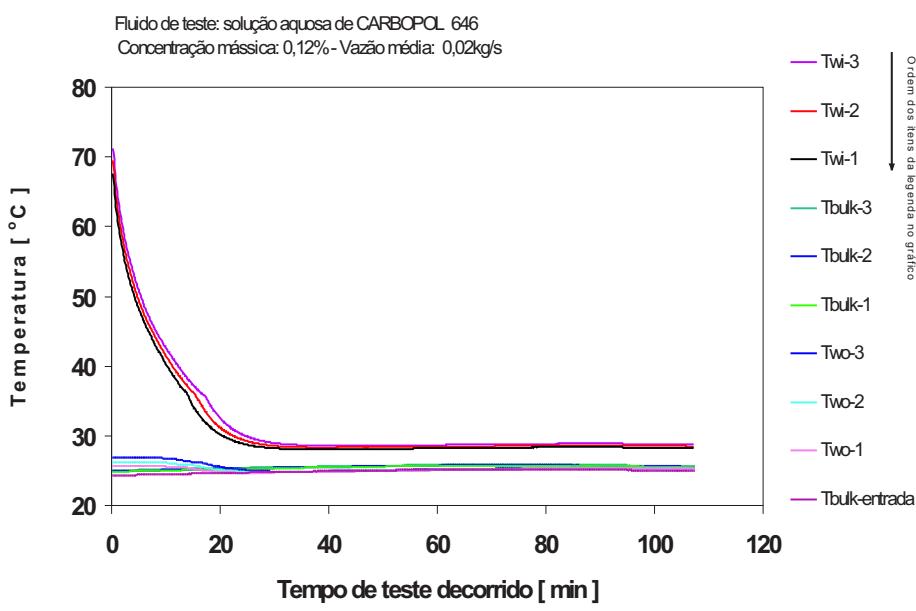
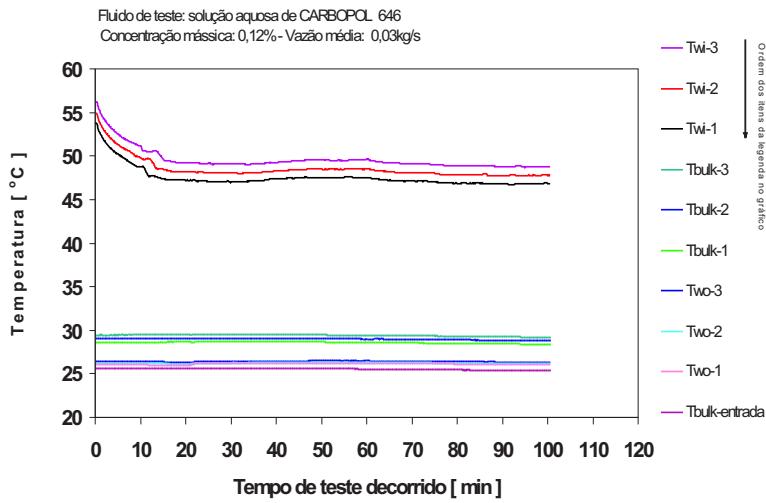
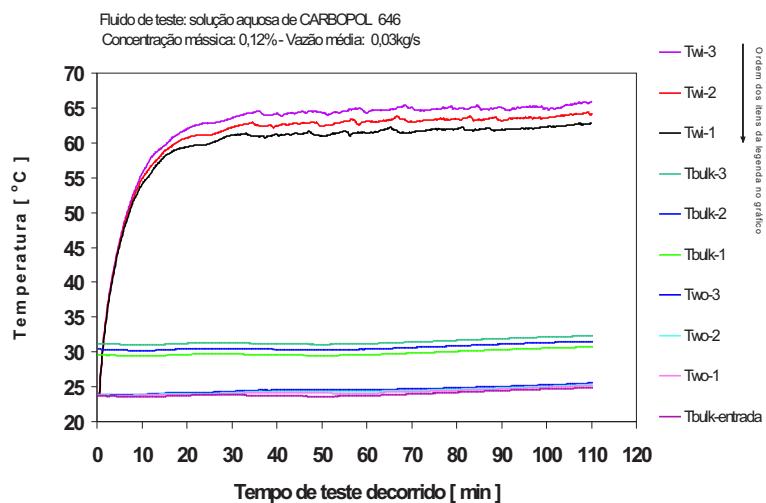


Figura A.2: fluxo de calor:  $202 \text{ W/m}^2$ ,  $R_i/R_o = 0,33$

Figura A.3: fluxo de calor:  $697 \text{ W/m}^2, R_i/R_o = 0,33$ Figura A.4: fluxo de calor:  $1184 \text{ W/m}^2, R_i/R_o = 0,33$

Figura A.5: fluxo de calor:  $1649 \text{ W}/\text{m}^2, R_i/R_o = 0,33$ Figura A.6: fluxo de calor:  $2181 \text{ W}/\text{m}^2, R_i/R_o = 0,33$

Figura A.7: fluxo de calor:  $3059 \text{ W}/\text{m}^2, R_i/R_o = 0,33$ Figura A.8: fluxo de calor:  $199 \text{ W}/\text{m}^2, R_i/R_o = 0,33$

Figura A.9: fluxo de calor:  $1938 \text{ W/m}^2, R_i/R_o = 0,33$ Figura A.10: fluxo de calor:  $3024 \text{ W/m}^2, R_i/R_o = 0,33$

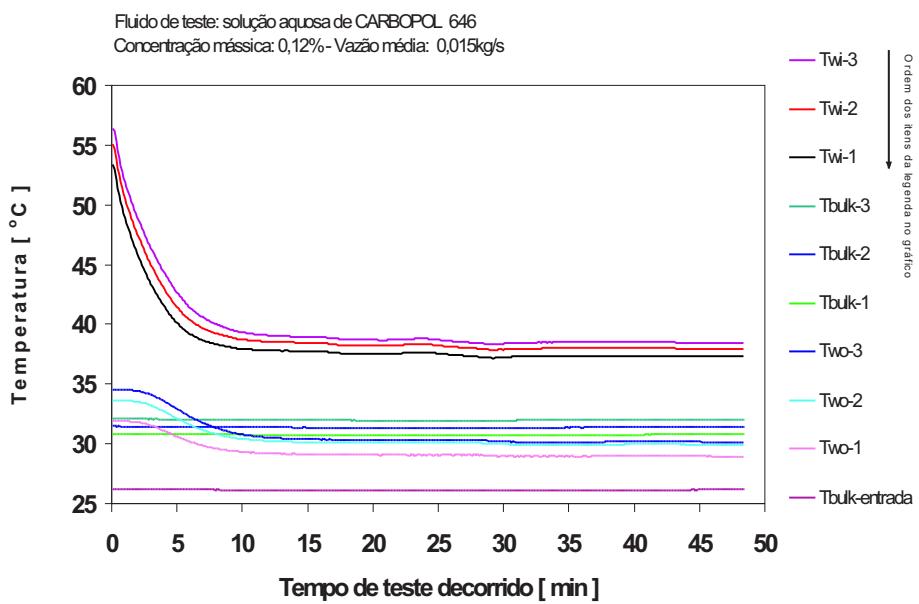
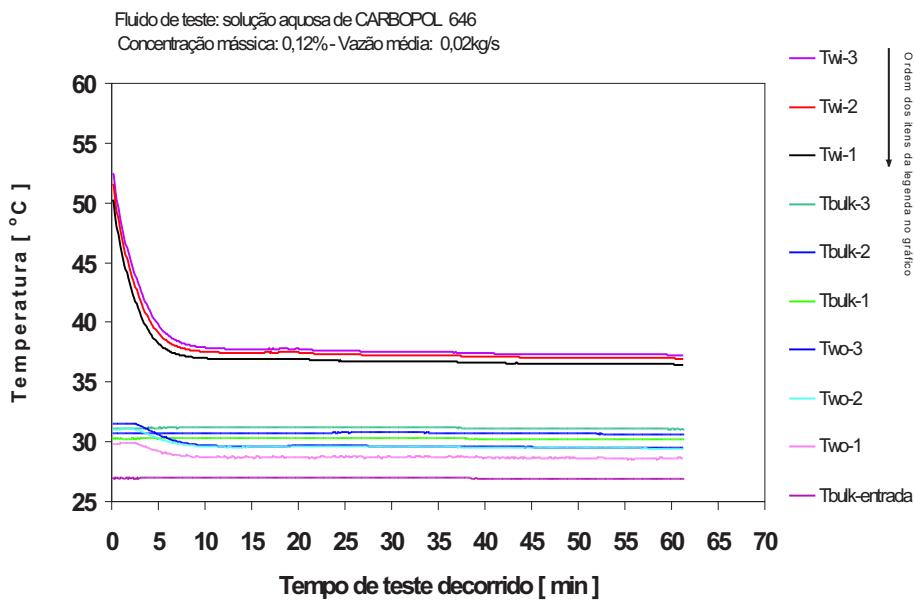
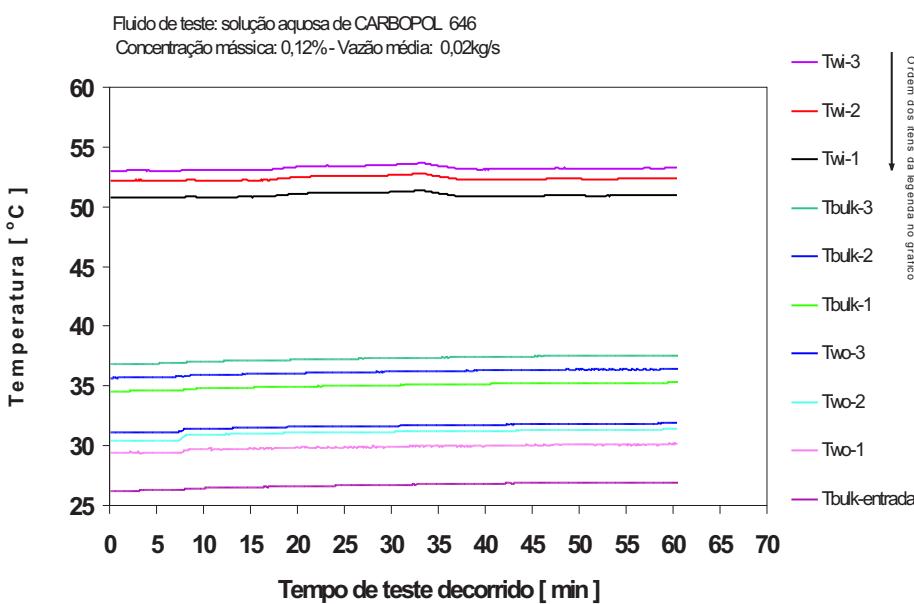


Figura A.11: fluxo de calor:  $1192 \text{ W/m}^2$ ,  $R_i/R_o = 0,58$

Figura A.12: fluxo de calor:  $1192 \text{ W/m}^2, R_i/R_o = 0,58$ Figura A.13: fluxo de calor:  $3008 \text{ W/m}^2, R_i/R_o = 0,58$

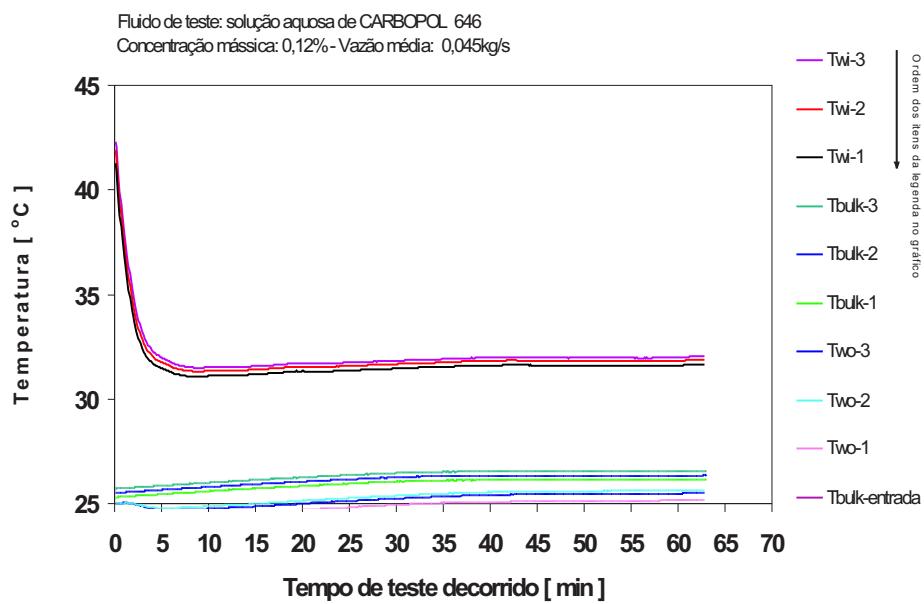
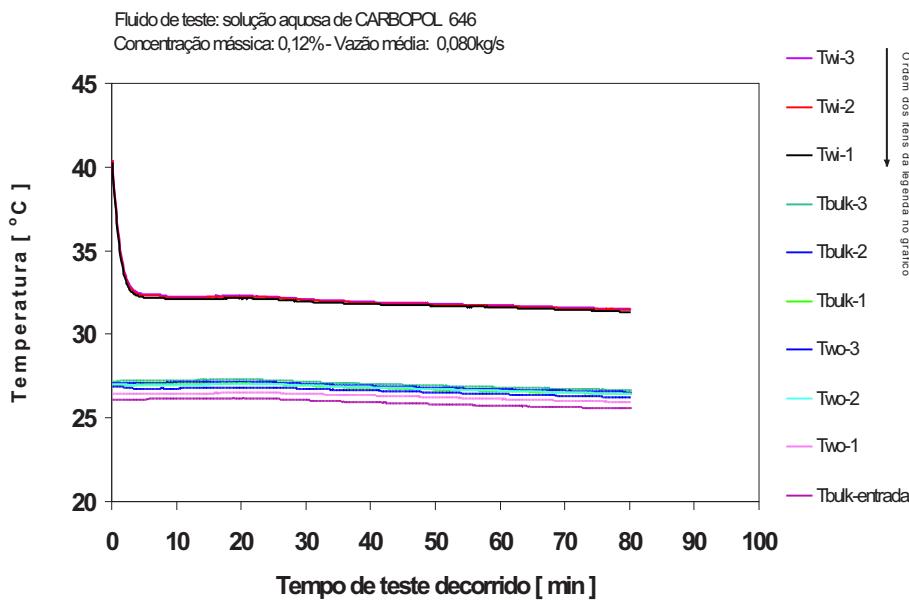
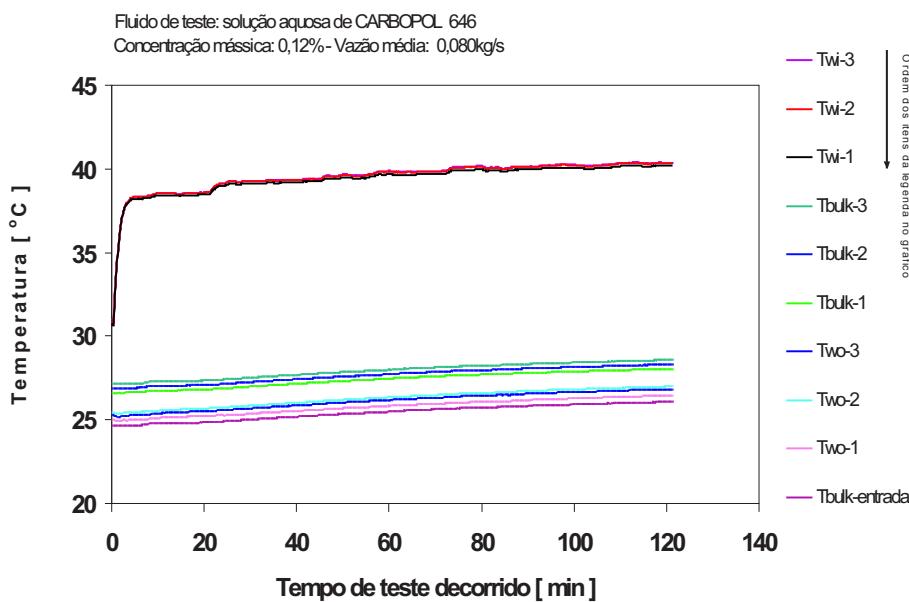


Figura A.14: fluxo de calor:  $1161 \text{ W/m}^2$ ,  $R_i/R_o = 0,58$

Figura A.15: fluxo de calor:  $1192 \text{ W/m}^2, R_i/R_o = 0,58$ Figura A.16: fluxo de calor:  $2929 \text{ W/m}^2, R_i/R_o = 0,58$

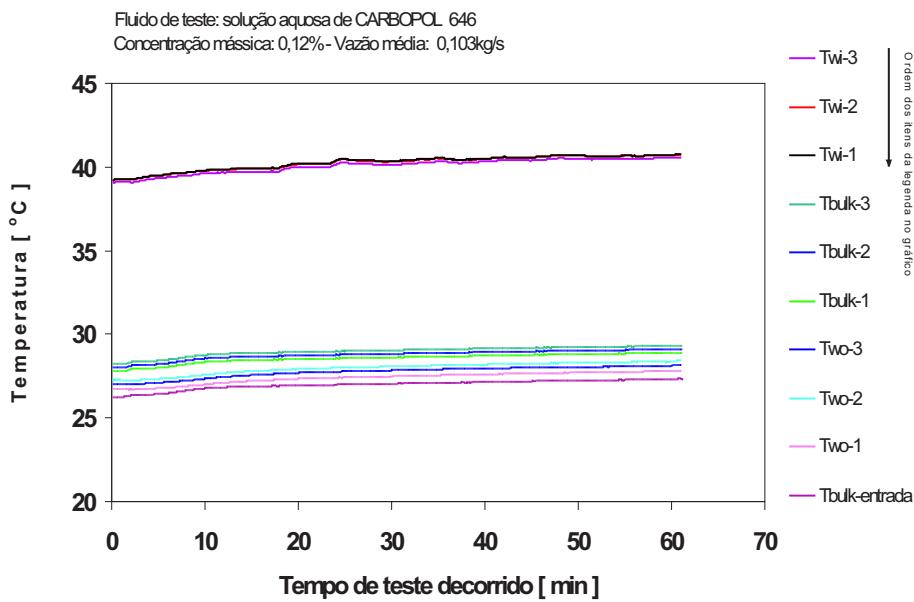


Figura A.17: fluxo de calor:3008  $W/m^2$ , $R_i/R_o = 0,58$

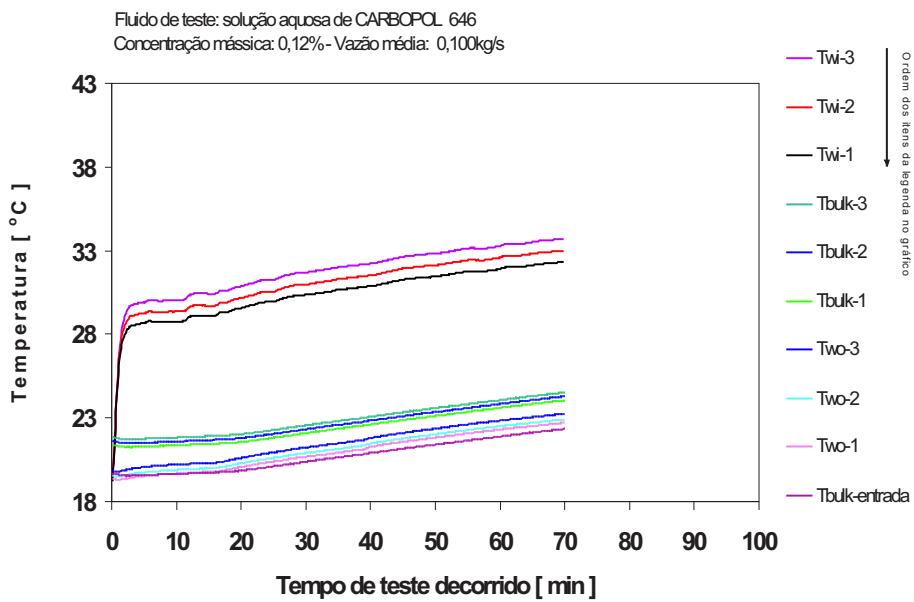


Figura A.18: fluxo de calor:  $2939 \text{ W/m}^2$ ,  $R_i/R_o = 0,69$

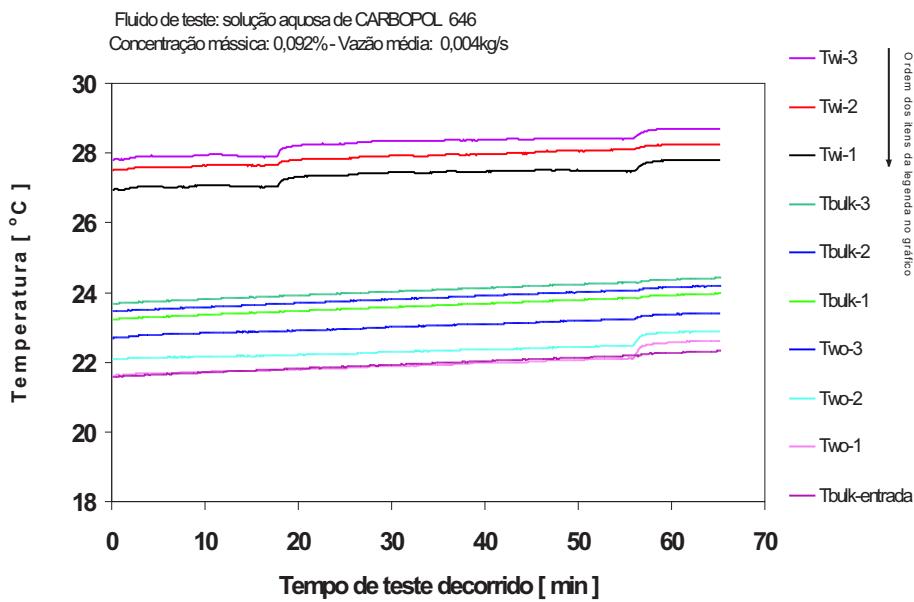
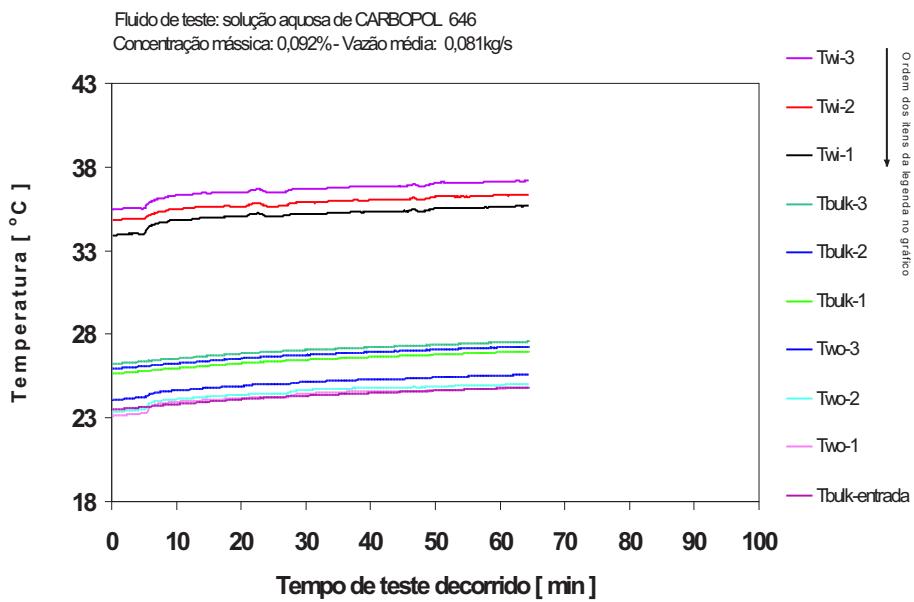


Figura A.19: fluxo de calor:  $1164 \text{ W/m}^2$ ,  $R_i/R_o = 0,69$

Figura A.20: fluxo de calor:  $2992 \text{ W/m}^2, R_i/R_o = 0,69$

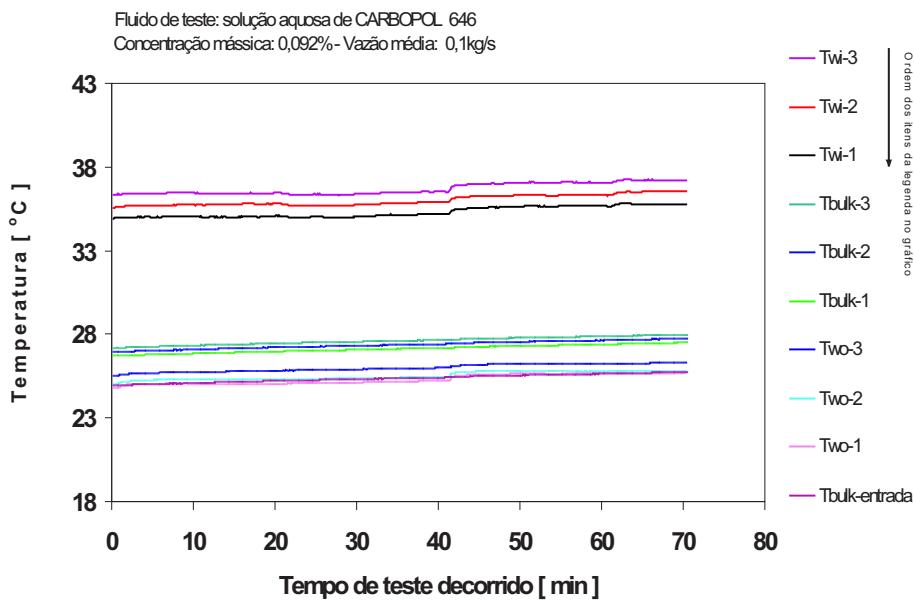
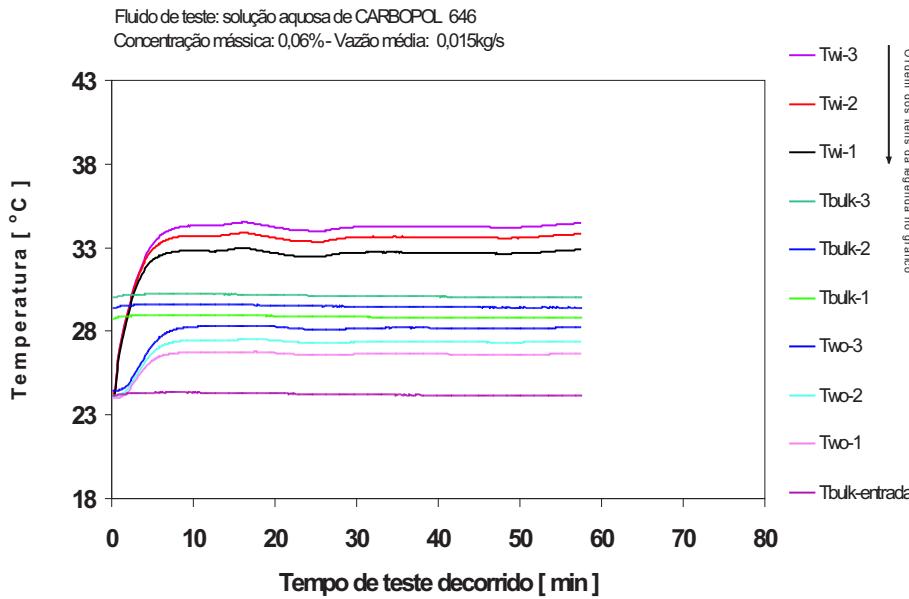
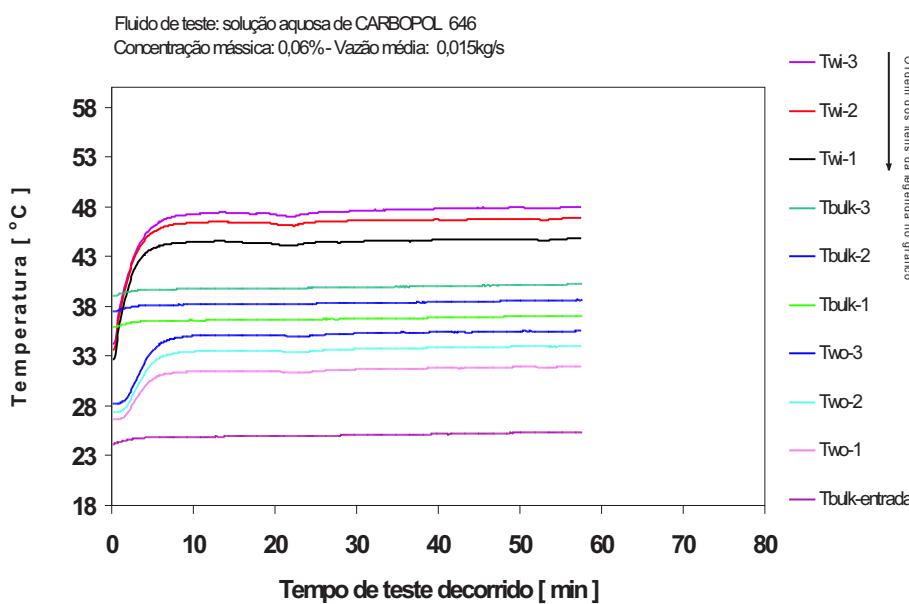


Figura A.21: fluxo de calor:  $3028 \text{ W/m}^2, R_i/R_o = 0,69$

Figura A.22: fluxo de calor:  $1194 \text{ W/m}^2, R_i/R_o = 0,69$ Figura A.23: fluxo de calor:  $3013 \text{ W/m}^2, R_i/R_o = 0,69$

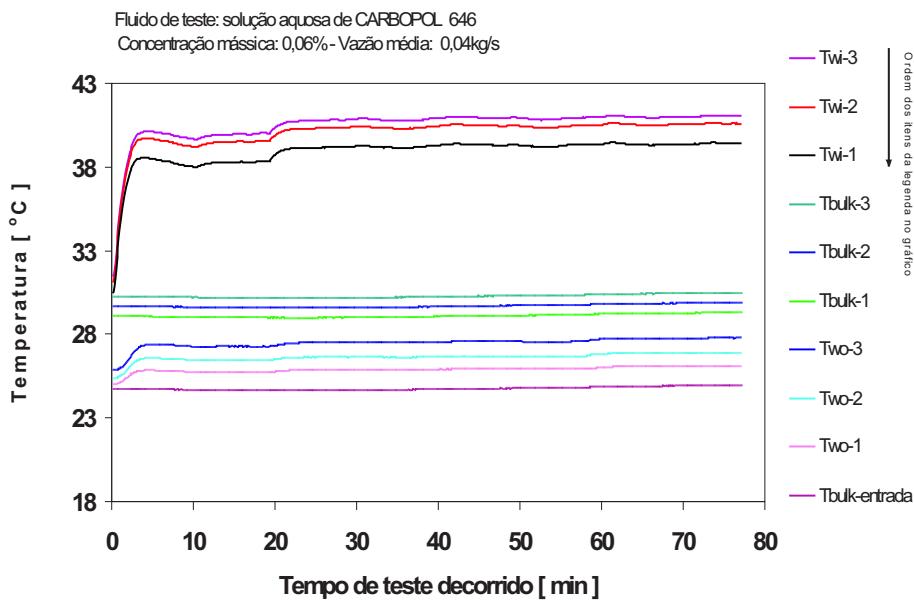
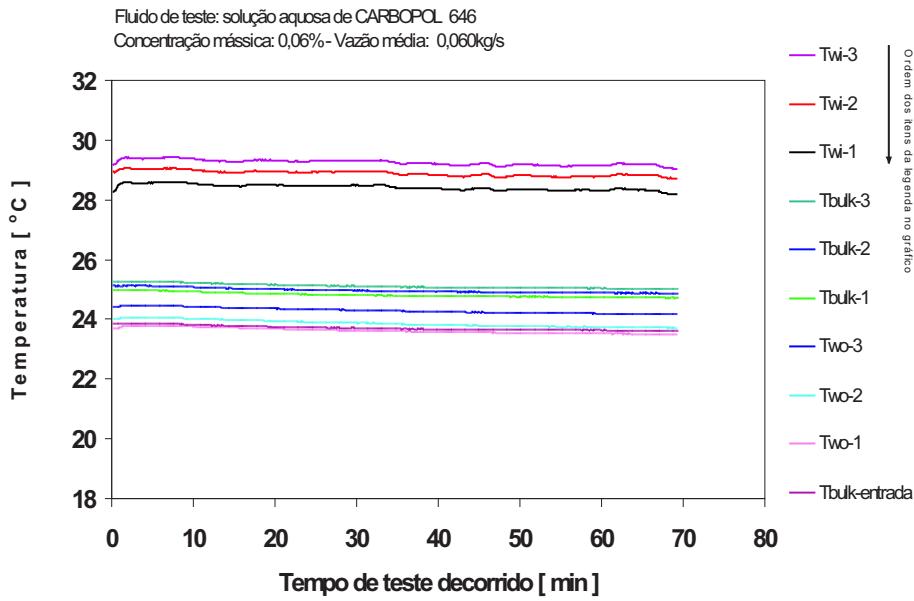
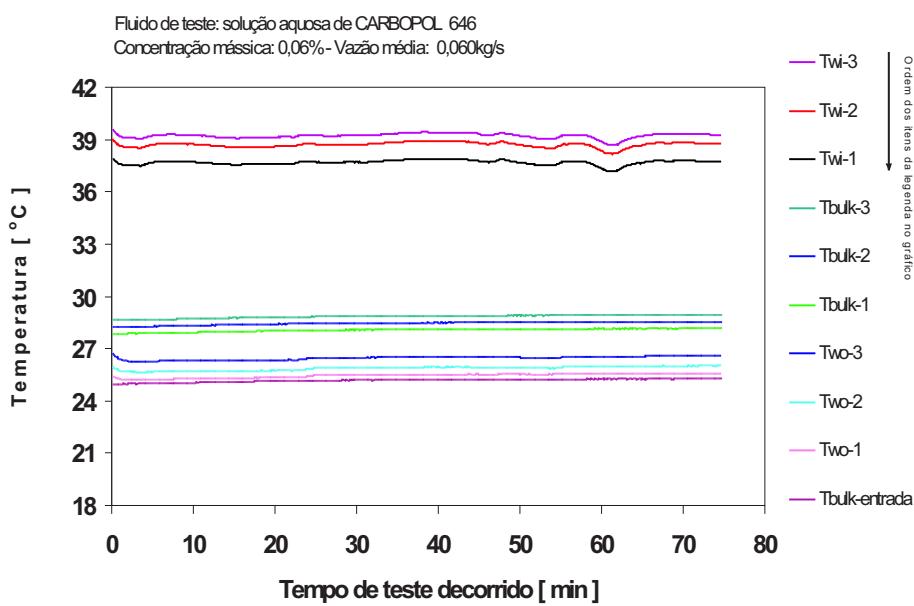
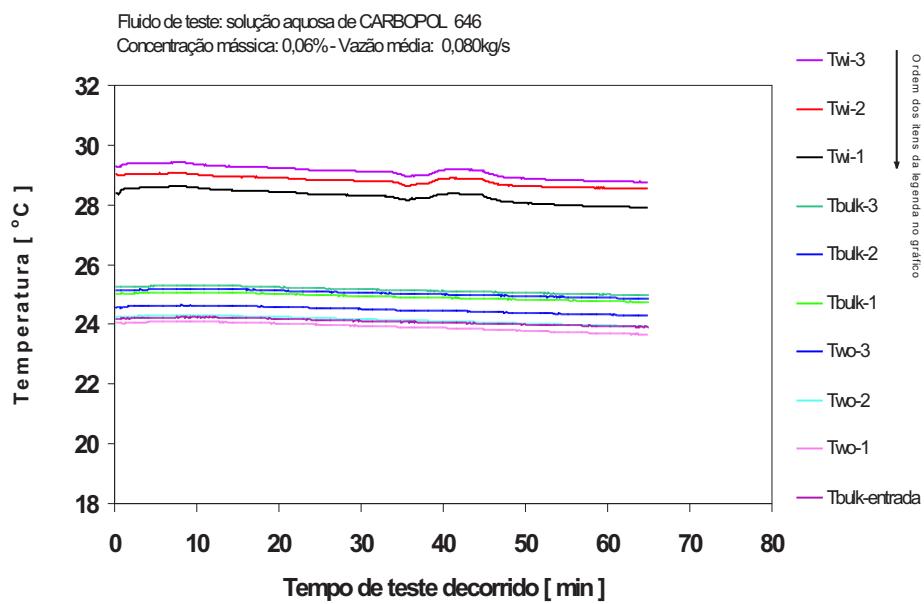
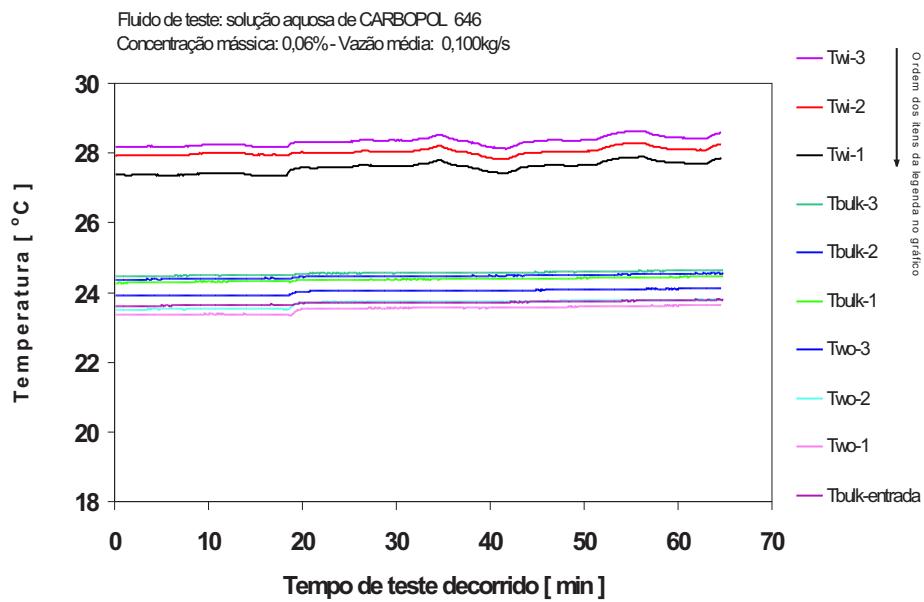


Figura A.24: fluxo de calor:  $2989 \text{ W/m}^2, R_i/R_o = 0,69$

Figura A.25:  $1139 \text{ W}/\text{m}^2, R_i/R_o = 0,69$ Figura A.26:  $2974 \text{ W}/\text{m}^2, R_i/R_o = 0,69$

Figura A.27:  $1145 \text{ W/m}^2, R_i/R_o = 0,69$

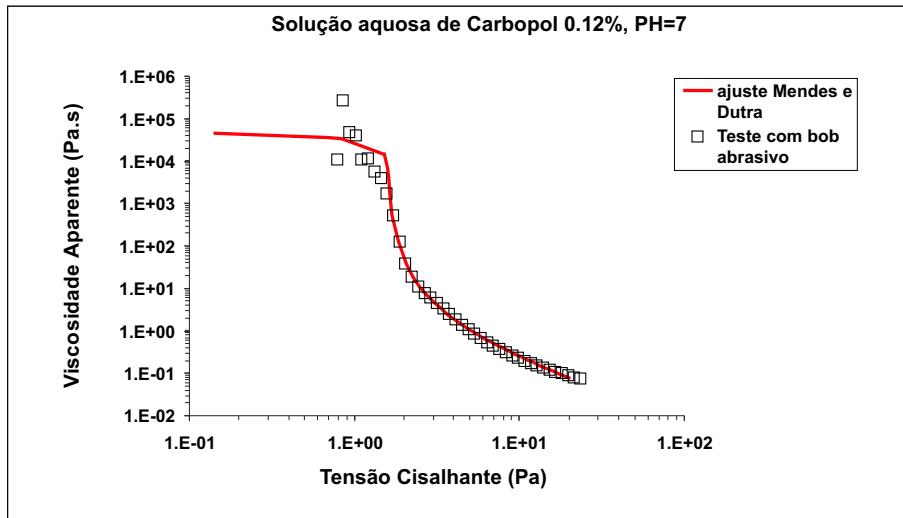
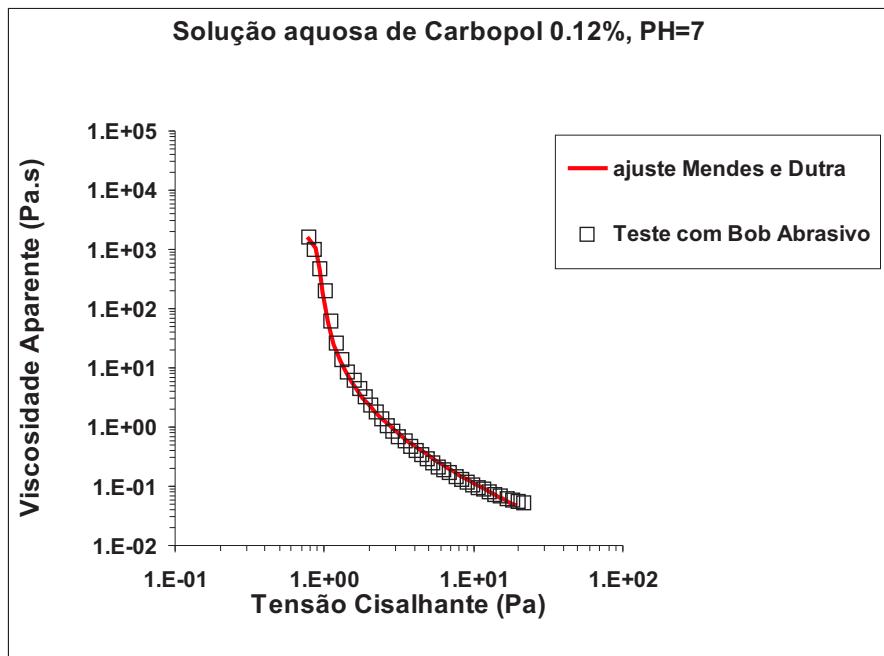
Figura A.28:  $1150 \text{ W/m}^2, R_i/R_o = 0,69$

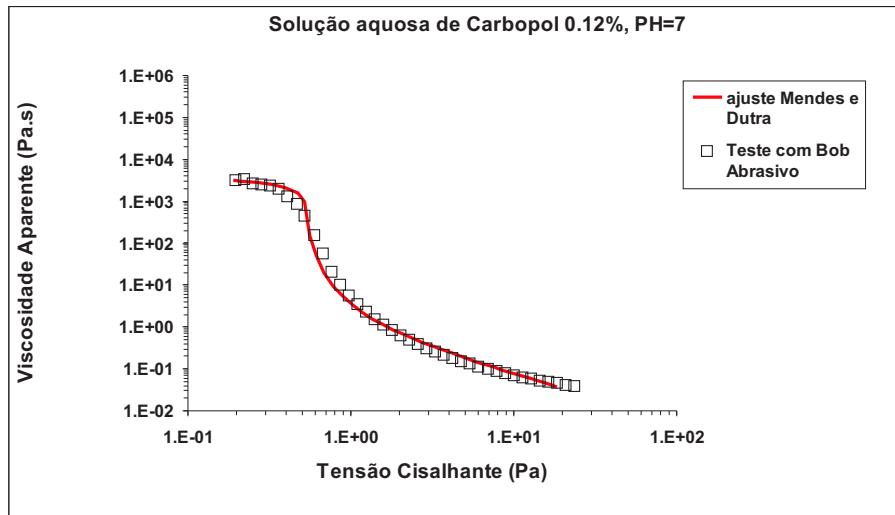
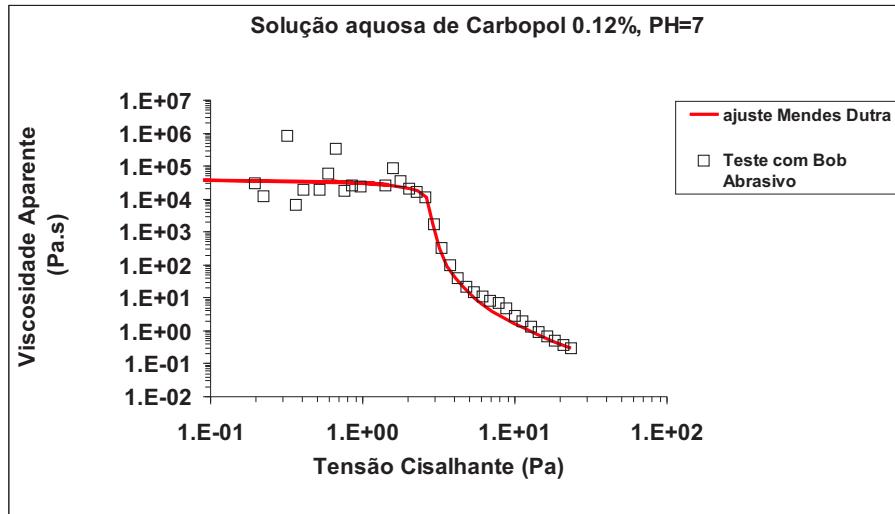
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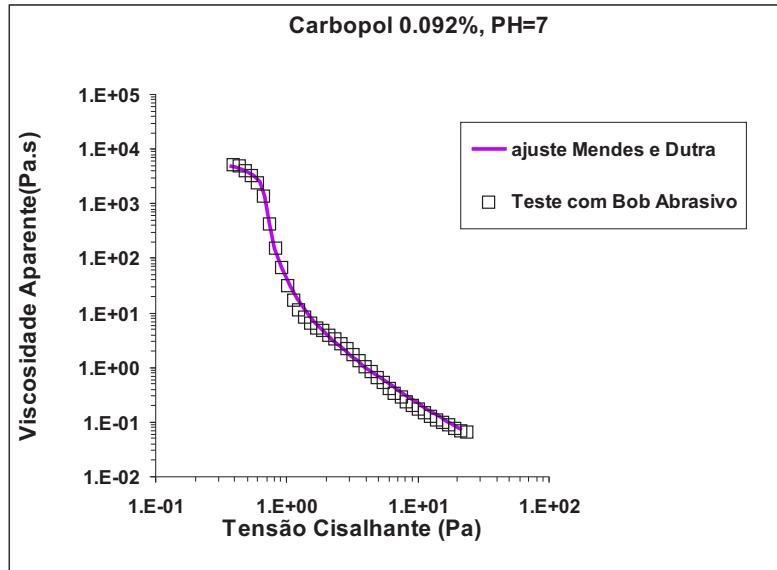
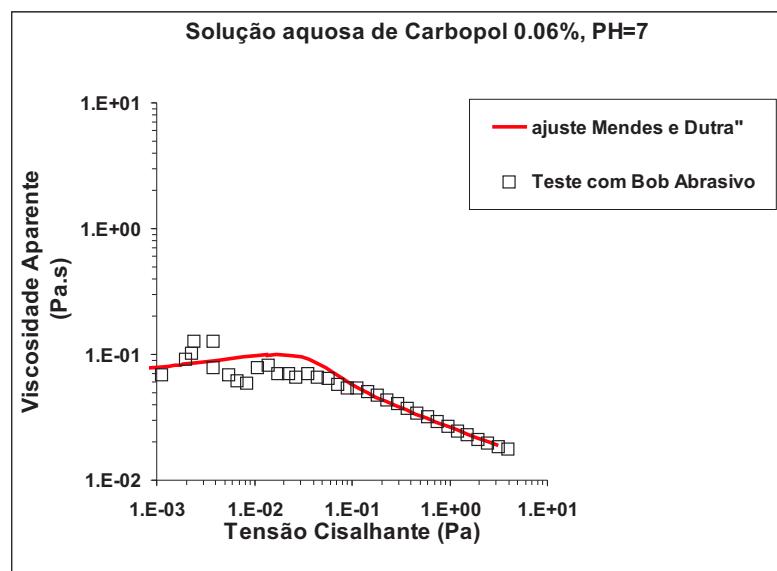
### **Apêndice**

#### **B.1**

##### **Curvas de Caracterização dos Fluidos**

Figura B.1:  $\tau_0 = 1,54 \text{ Pa}$ ,  $K=1,8 \text{ Pa.s}$ ,  $n=0,42$ Figura B.2:  $\tau_0 = 0,85 \text{ Pa}$ ,  $K=1,22 \text{ Pa.s}$ ,  $n=0,45$

Figura B.3:  $\tau_0 = 0,5\text{Pa}$ ,  $K=0,92\text{Pa.s}$ ,  $n=0,48$ Figura B.4:  $\tau_0 = 2,6\text{Pa}$ ,  $K=3,6\text{Pa.s}$ ,  $n=0,40$

Figura B.5:  $\tau_0 = 0,46\text{Pa}$ ,  $K=1,9\text{Pa.s}$ ,  $n=0,42$ Figura B.6:  $\tau_0 = 0,011\text{Pa}$ ,  $K=0,058\text{Pa.s}$ ,  $n=0,78$