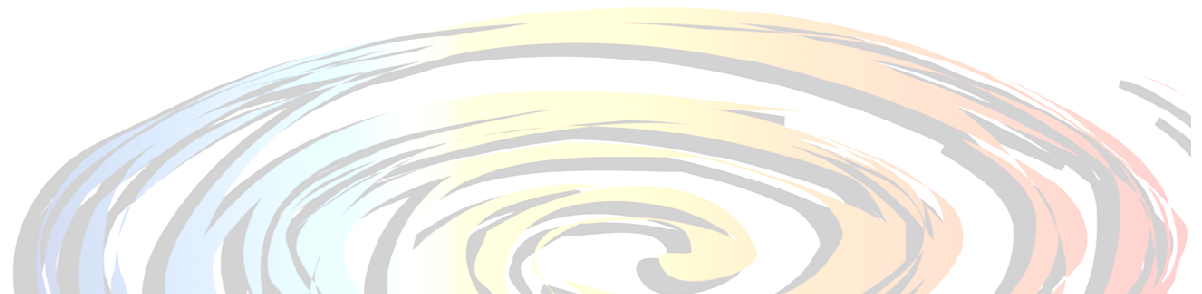




CARACTERISATION THERMIQUE TRANSITOIRE PAR LA MESURE DE DEUX TEMPERATURES :

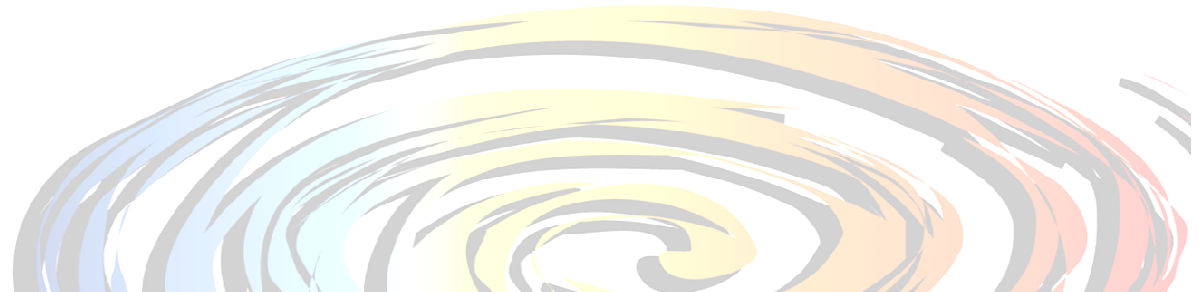
2 – APPLICATION A UNE GEOMETRIE CYLINDRIQUE TRICOUICHE

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INTRODUCTION

- Matériaux isolants pulvérulents
- Technique du fil chaud :
 - Nombre de points de contact très petits
 - Milieu semi-infini
 - Mesure de λ
- Tri-couche cylindrique :
 - Nombre de points de contact importants
 - Milieu fini
 - Mesure de λ et ρc

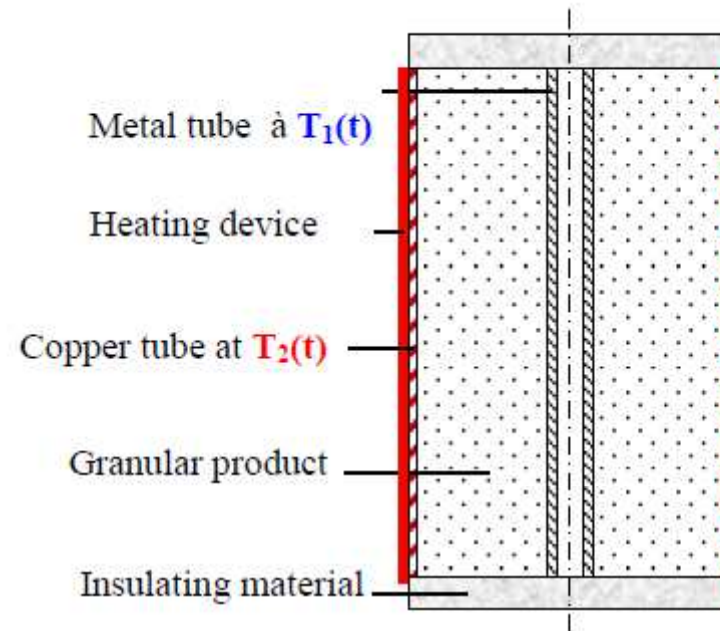


DISPOSITIF

Hauteur : 38 cm

Tube intérieur en acier :
diamètre 8/9

Tube extérieur en cuivre :
diamètre 78/80 mm ou
49/50 mm

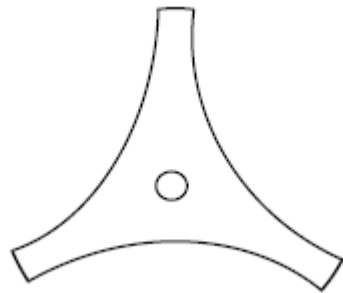


Précautions

- Isolation supérieure et inférieure
- Mesure de température $T_2(t)$ en deux points diamétralement opposés
- Equilibre thermique à $t = 0$

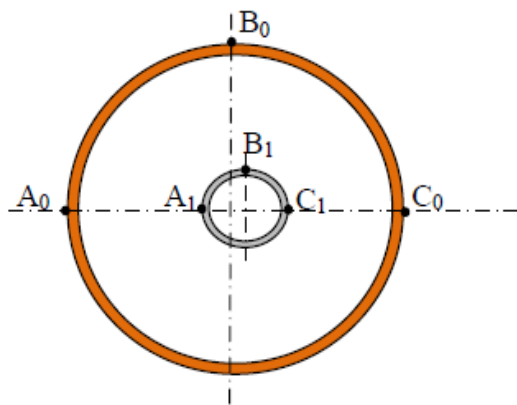
DISPOSITIF

- Isolation supérieure et inférieure



PVC rigide $\lambda = 0,065 \text{Wm}^{-1}\text{K}^{-1}$

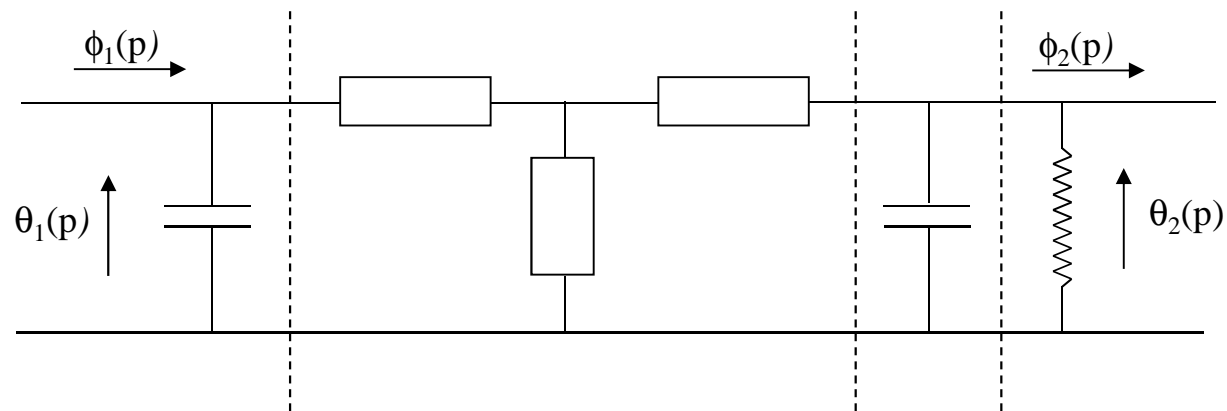
- Décentrage des tubes



		Temperature measurement			
		A	B	C	Mean (A,C)
Glass	λ	6.7	-0.66	-9.2	-0.66
	ρc	7.0	-0.61	-9.5	-0.66
	a	-0.24	0.04	0.30	0.03

MODELISATION

Par méthode quadripolaire :



$$\begin{bmatrix} \theta_1(p) \\ 0 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ C_1 p & 1 \end{bmatrix} \begin{bmatrix} A & B \\ C & D \end{bmatrix} \begin{bmatrix} 1 & 0 \\ C_2 p & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ hS & 1 \end{bmatrix} \begin{bmatrix} \theta_2(p) \\ \phi_2(p) \end{bmatrix}$$

avec $\phi_2(p) = -\frac{\varphi_0 S [1 - \exp(-pt_c)]}{p}$

MODELISATION

$$A = qr_2 [K_1(qr_2)I_0(qr_1) + K_0(qr_1)I_1(qr_2)]$$

$$B = \frac{1}{2\pi\lambda L} [K_0(qr_1)I_0(qr_2) - K_0(qr_2)I_0(qr_1)]$$

$$C = 2\pi L \rho c p r_1 r_2 [K_1(qr_1)I_1(qr_2) - K_1(qr_2)I_1(qr_1)]$$

$$D = qr_1 [K_0(qr_2)I_1(qr_1) + K_1(qr_1)I_0(qr_2)]$$

$$C_1 = m_1 c_1 \quad C_2 = m_2 c_2 \quad q = \sqrt{\frac{p}{a}}$$

on obtient

$$\theta_1(p) = \frac{\phi_2(p)}{AC_1 p + C + C_2 p(BC_1 p + D) + hS(BC_1 p + D)}$$

$$\theta_1(p) = \frac{\phi_2(p)(BC_1 p + D)}{AC_1 p + C + C_2 p(BC_1 p + D) + hS(BC_1 p + D)}$$

soit

$$\theta_1(p) = H(p)\theta_2(p) \quad \text{avec} \quad 1/H(p) = BC_1 p + D$$

ou encore

$$T_1(t) = T_2(t) \otimes F(t) \quad \text{avec} \quad F(t) = L^{-1}[H(p)]$$

ESTIMATION DES PARAMETRES

- classiquement : $G = \sum (T_{1\text{mes}} - T_{1\text{mod}})^2$

avec $T_{1\text{mod}}(t, \lambda, \rho c, C_1, C_2, h, \varphi_0)$

- 2 températures : $G = \sum (T_{1\text{mes}} - T_{2\text{mes}} \otimes F)^2$

avec $F(t, \lambda, \rho c)$

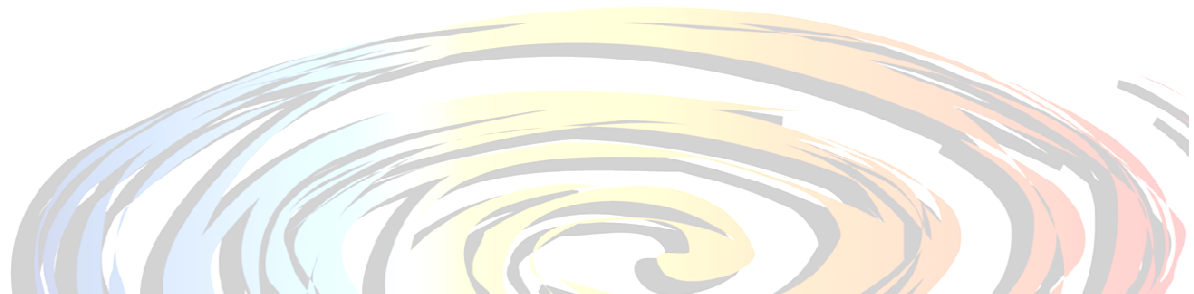
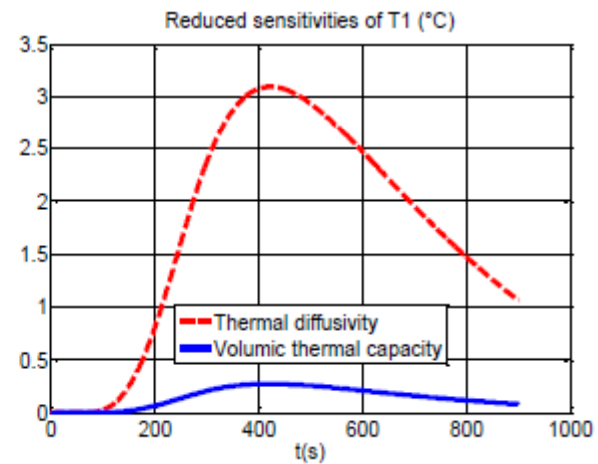
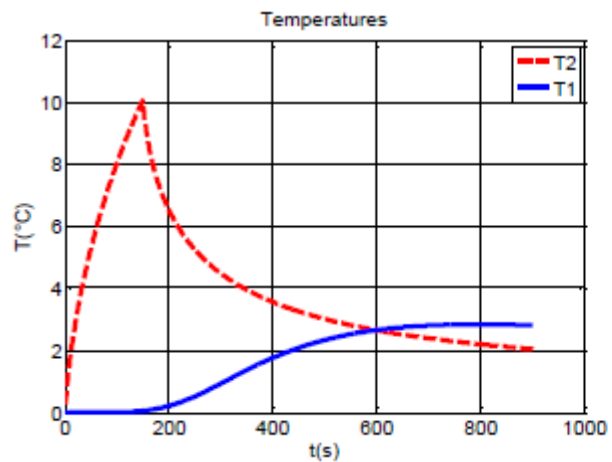
ANALYSE DES SENSIBILITES

$$a \frac{\partial T_1}{\partial a}(t) = T_2(t) \otimes a \frac{\partial F}{\partial a}(t)$$

$$\rho c \frac{\partial T_1}{\partial \rho c}(t) = T_2(t) \otimes \rho c \frac{\partial F}{\partial \rho c}(t)$$

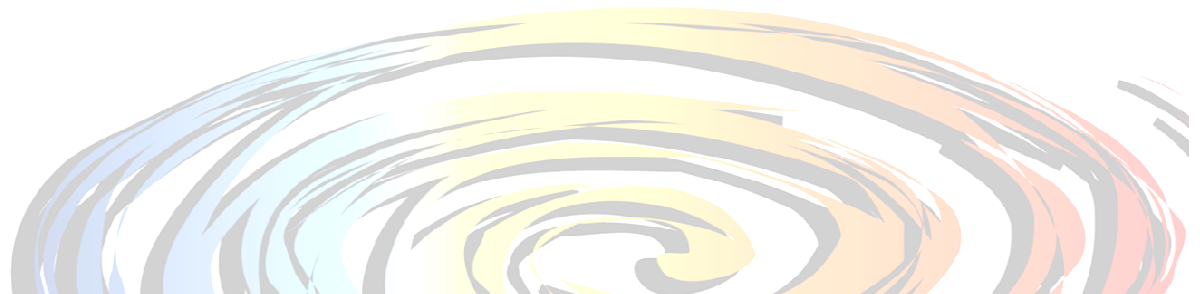
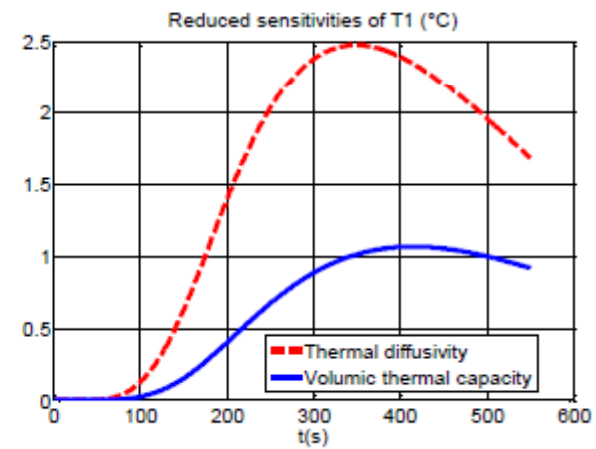
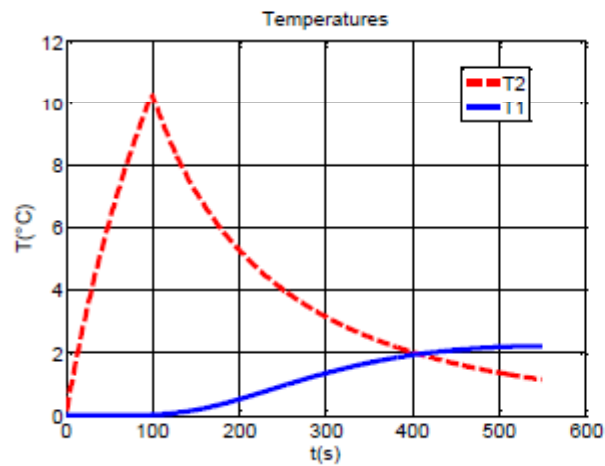
ANALYSE DES SENSIBILITES

- Billes de verre



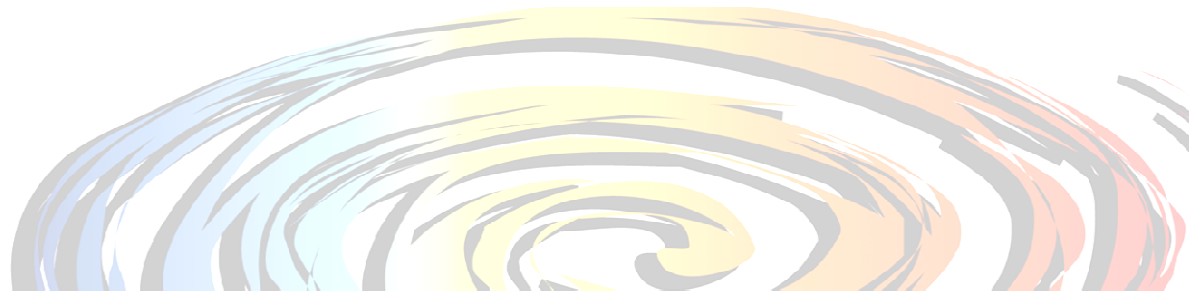
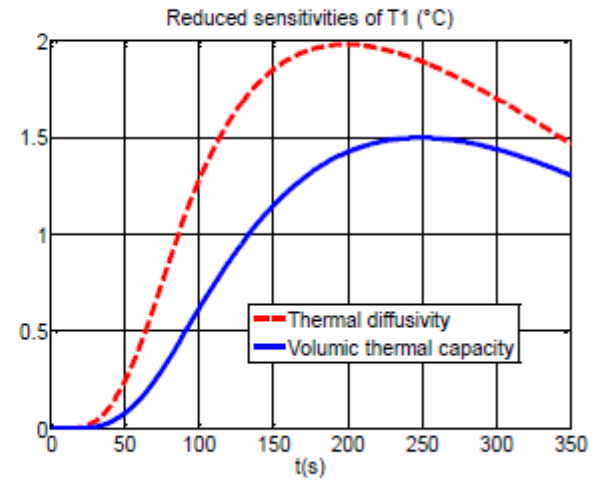
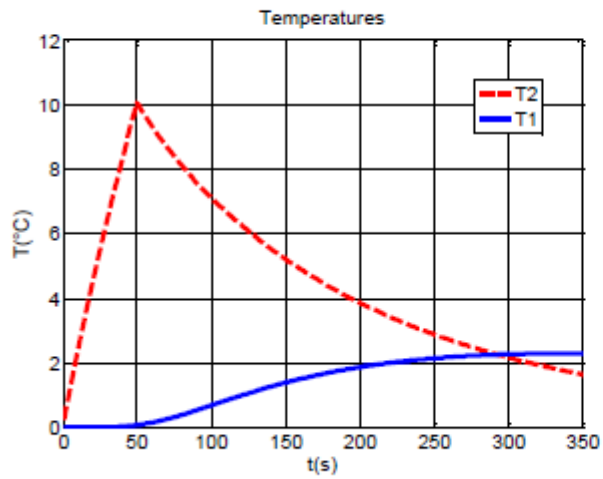
ANALYSE DES SENSIBILITES

- Granulés de liège



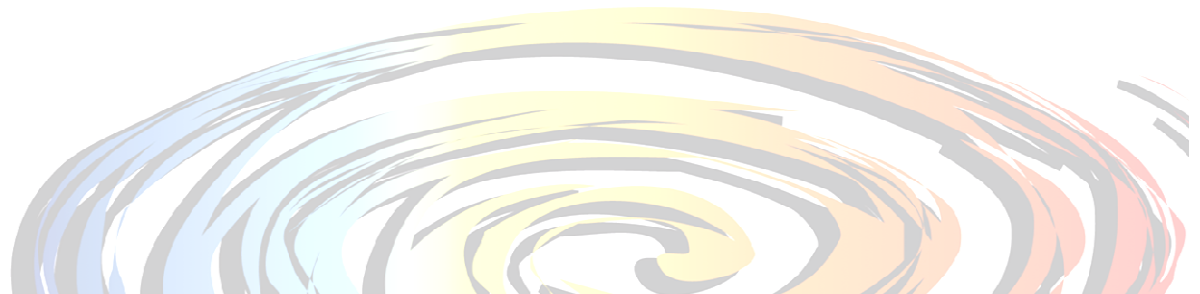
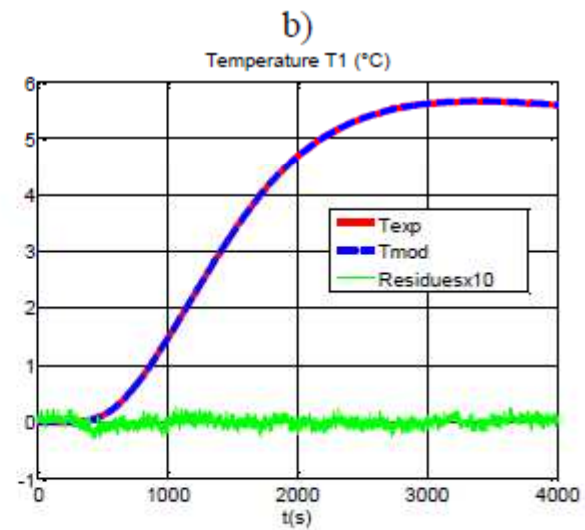
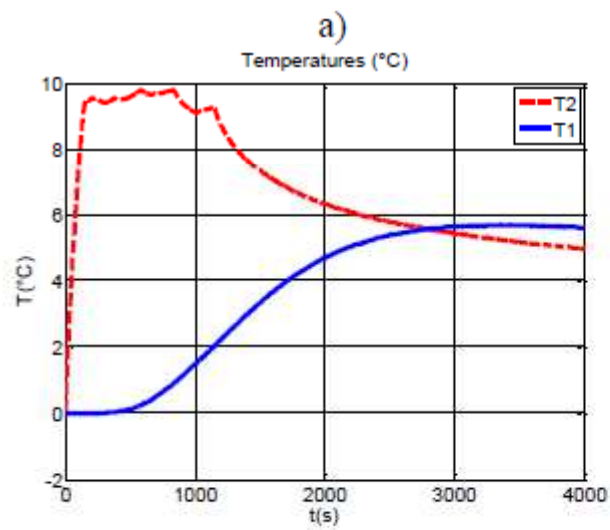
ANALYSE DES SENSIBILITES

- Billes de polystyrène



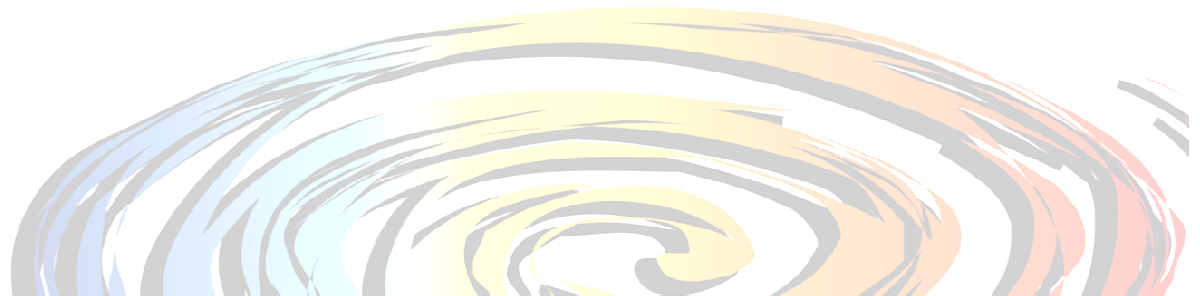
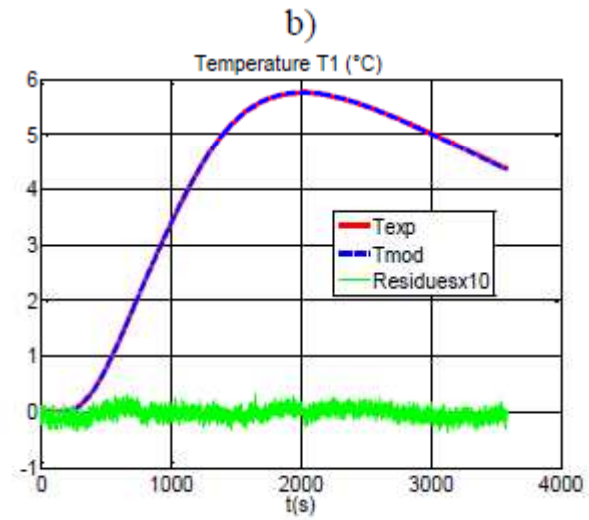
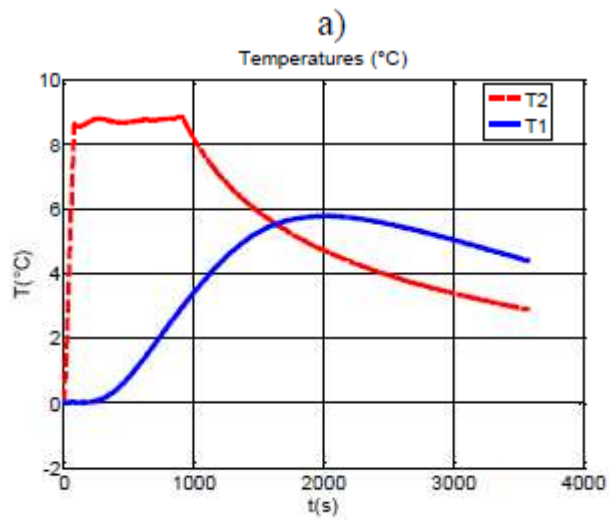
RESULTATS

- Billes de verre



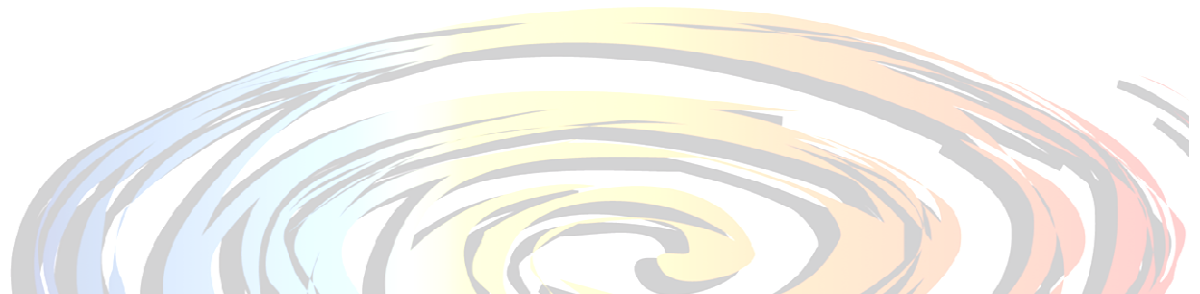
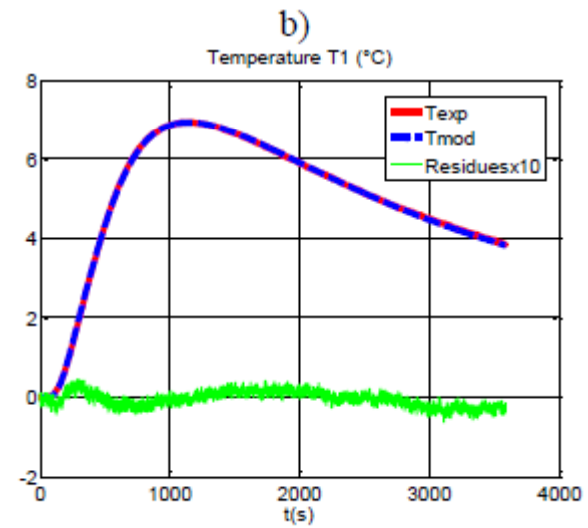
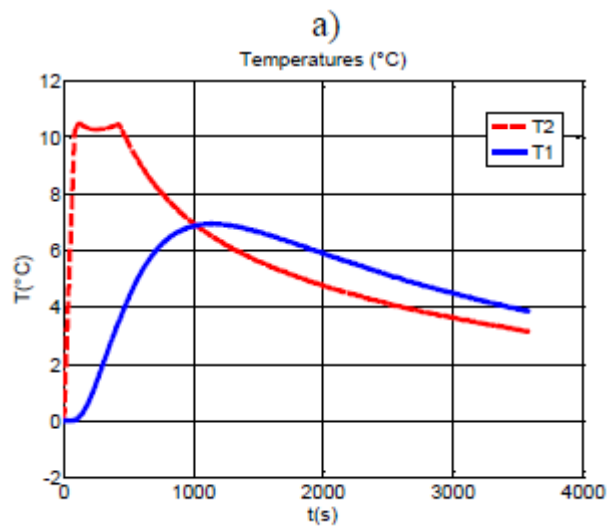
RESULTATS

- Granulés de liège



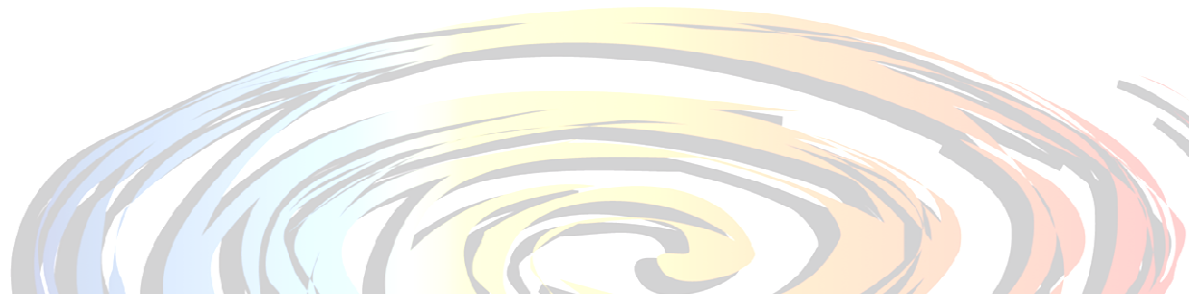
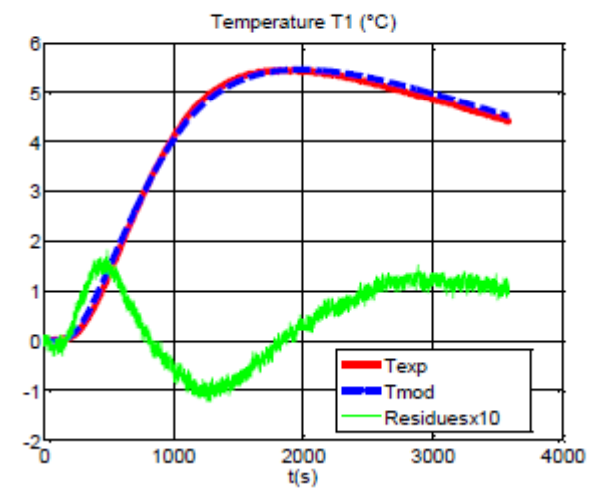
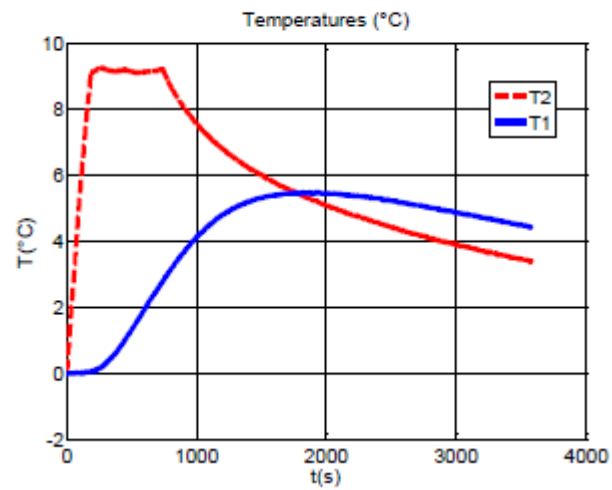
RESULTATS

- Billes de polystyrène



RESULTATS

- Granulés de liège avec 3 % d'humidité (en équilibre)



ESTIMATION DES ERREURS

		Polystyrene			Cork			Glass		
		λ	ρc	a	λ	ρc	a	λ	ρc	a
Thermal properties		0.035	2.5×10^4	1.40×10^{-6}	0.038	1.1×10^5	3.45×10^{-7}	0.22	1.23×10^6	1.69×10^{-7}
Systematic errors	$r_1 \pm 0.1 \text{ mm}$	0.69	0.06	0.75	0.43	1.47	1.06	14.1	14.3	0.21
	$r_2 \pm 0.1 \text{ mm}$	0.19	0.41	0.61	0.16	0.79	0.63	1.26	0.77	0.50
	$m_1 c_1 \pm 0.01$	1.09	1.09	0.004	1.09	1.09	0.003	1.19	1.20	0.004
	$m_1 c_1$	1.09	1.09	0.004	1.09	1.09	0.003	1.19	1.20	0.004
Maximum deviation (%)		1.97	1.56	1.36	1.68	3.35	1.69	16.6	16.3	0.71

		Estimation time	Mean estimated values			Standard Deviations (%)		
	t_c	t_{estim} (s)	λ ($\text{W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$)	ρc ($\text{J} \cdot \text{m}^{-3} \cdot \text{K}^{-1}$)	a ($\text{m}^2 \cdot \text{s}^{-1}$)			
Glass	400	1950	0.22	1.23×10^6	1.69×10^{-7}	8.4	8.8	0.40
Cork	280	1270	0.038	1.1×10^5	3.45×10^{-7}	0.84	1.2	0.35
Polystyrene	250	750	0.035	2.5×10^4	1.40×10^{-6}	0.23	0.53	0.31



RESULTATS

Material	Glass	Cork	Polystyrene
T_{mean}	30°C	28°C	28°C
$a \text{ (m}^2 \cdot \text{s}^{-1}\text{)}$	1.564×10^{-7}	3.45×10^{-7}	1.377×10^{-6}
$\rho c \text{ (J} \cdot \text{m}^{-3} \cdot \text{K}^{-1}\text{)}$	0.965×10^6	1.113×10^5	26443
$\lambda \text{ (W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}\text{)}$	0.151	0.0384	0.0364

Material	Glass	Cork	Polystyrene
T_{mean}	30°C	28°C	28°C
$\rho c_{\text{DSC}} \text{ (J} \cdot \text{m}^{-3} \cdot \text{K}^{-1}\text{)}$	$1.20 \cdot 10^6$	$1,124 \cdot 10^7$	25882
$\rho c_{\text{Three layers}} \text{ (J} \cdot \text{m}^{-3} \cdot \text{K}^{-1}\text{)}$	$0,965 \times 10^6$	1.113×10^5	26443
Deviation (%)	19.6	1.0	2.1





FIN

