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## Operator THER\_NON\_LINE\_MO

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### 1 Drank

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Compute the nonlinear steady thermal response with mobile loading.

This operator allows to solve the equation of steady heat in a mobile reference frame related to a loading and moving in a given direction and at a velocity [R5.02.04].

Nonthe linearities of the problem come as well from the characteristics of the material which depend on the temperature, as boundary conditions of type radiation.

The problems of this type can be treated with models using of the finite elements structure planes, axisymmetric and three-dimensional.

The product concept by this operator is of `evol_ther` type as for an analysis by `THER_LINEAIRE` [U4.54.01] or `THER_NON_LINE` [U4.54.02], but it contains one sequence number since a steady computation is carried out.

## 2 Syntax

```
temper [evol_ther] = THER_NON_LINE_MO  
  
( ◆MODELE=mo , [model]  
  
◆CHAM_MATER=chmat , [cham_mater]  
  
◆EXCIT=_F ( [char_ther]  
◆CHARGE=char ,  
) ,  
  
◇ ETAT_INIT=_F ( [evol_ther]  
◆EVOL_THER=temp , [I]  
◇NUMÉRIQUE_ORDRE=/nuinievol , [DEFAULT]  
/0 ,  
) ,  
  
◇CONVERGENCE=_F ( [DEFAULT]  
◇CRIT_TEMP_RELA=/1.E-3 , [R]  
/testr , [DEFAULT]  
◇CRIT_ENTH_RELA=/1.E-2 , [R]  
/testl , [DEFAULT]  
◇ITER_GLOB_MAXI=/10 , [R]  
/iterl ,  
) ,  
  
◇SOLVEUR=_F ( ... to see document [U4.50.01]...  
) ,  
  
◇TITER=titer , [l_Kn]  
  
)
```

## 3 Operands

### 3.1 MODEL Operand

◆MODELE = Mo

Name of the model whose elements are the object of thermal computation.

### 3.2 Operand CHAM\_MATER

◆CHAM\_MATER = chmat

Name of the affected material field on the model.

### 3.3 Key word EXCIT

◆EXCIT =

Key word factor allowing to define several loadings. For each occurrence of the key word factor, one defines a time-constant load.

#### 3.3.1 Operand CHARGE

◆CHARGE = tank

Concept of the type charges produces by AFFE\_CHAR\_THER or AFFE\_CHAR\_THER\_F [U4.44.02].

#### Important remarks:

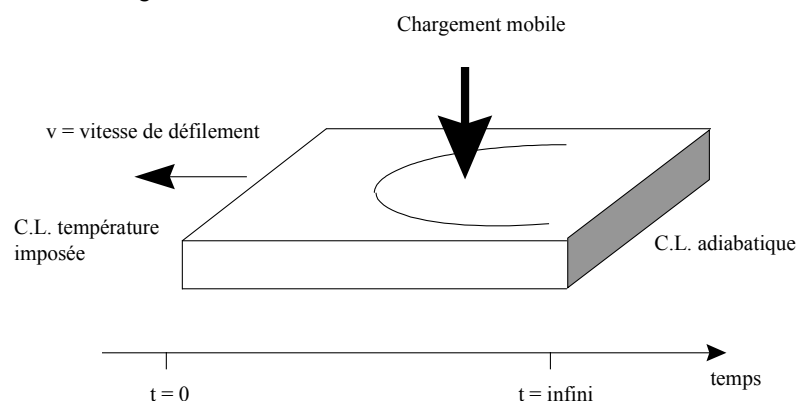
*For each occurrence of the key word factor EXCIT the various concepts tank used must be built on the same model Mo .*

*In addition, operator AFFE\_CHAR\_THER or AFFE\_CHAR\_THER\_F must obligatorily inform under the key word factor CONVECTION a concept of the cham\_no\_DEPL\_R type defining the rate of travel of the field and product by CREA\_CHAMP .*

*It is necessary to take care to define coherent boundary conditions with the run of the part (or of the loading, according to the selected reference frame) and the assumption of stationarity:*

*If the solid is animated of a uniform translatory movement at constant velocity, it is equivalent to consider the calculated field of temperature:*

- like a photograph at a given time,*
- or like a temporal succession of the card of temperature in a section of fixed, orthogonal X-coordinate with the direction of run.*



*Thus, downstream in space (early in time), the boundary condition on edge of the part must impose the temperature of the part before arrives the mobile loading. Upstream in space (or late in time), a heat flux no one (adiabaticity) guarantees the assumption of stationarity.*

## 3.4 Key word ETAT\_INIT

◇ETAT\_INIT

Makes it possible to define the initial field from which computation out of mobile coordinate system under condition of stationarity is carried out.

### 3.4.1 Operand EVOL\_THER

◆ EVOL\_THER = temp

Name of data structure of the evol\_ther type whose is extracted the field from temperature from which is calculated the solution with the problem.

### 3.4.2 Operand NUME\_ORDRE

◇NUMÉRIQUE\_ORDRE =/nuini\_evol  
/0 [DEFAULT]

Sequence number of the field to be extracted from this data structure.

#### Note:

*For this kind of computation, there is no initial condition to define (it is defined with a boundary condition on an edge of the field defined by the model). But, one can nevertheless only carry out steady computation from a field of temperature already calculated like solution of the problem for part of the load. That can be useful if the application of the totality of the loading makes convergence difficult. One can then connect several resolutions with a loading which evolves gradually and take as reiterated first of a computation running the solution of preceding computation. Concretely, one uses key word ETAT\_INIT then to define the field of temperature with which one wants to initialize current computation.*

## 3.5 Key word CONVERGENCE

◇CONVERGENCE =

Makes it possible to define the values associated with the convergence criteria:

### 3.5.1 Operand CRIT\_TEMP\_RELA

◇CRIT\_TEMP\_RELA = 1.e-3  
/testr

the algorithm continues the iterations as long as the relative variation of reiterated is higher than testr.

$$\left( \sum_{i=1, \dots, nbddl} (T_i^n - T_i^{n-1})^2 \right)^{1/2} / \left( \sum_{i=1, \dots, nbddl} (T_i^n)^2 \right)^{1/2} > testr$$

where  $T_i^n$  the value of the temperature to node I for the nth iteration indicates.

## 3.5.2 Operand CRIT\_ENTH\_REL

◇CRIT\_ENTH\_REL = 1.e-2  
/test1

the algorithm continues the iterations as long as the relative variation of reiterated is higher than test1.

$$\left( \sum_{i=1, \dots, N} (\beta_i^n - \beta_i^{n-1})^2 \right)^{1/2} / \left( \sum_{i=1, \dots, N} (\beta_i^n)^2 \right)^{1/2} > test1$$

where  $\beta_i^n$  the value of the enthalpy to the nth iteration at the 2nd Gauss point indicates.

## 3.5.3 Operand ITER\_GLOB\_MAXI

◇ITER\_GLOB\_MAXI = 10  
/iter1

the algorithm continues the external iterations as long as the nombre of iterations external is lower than iter1.

## 3.6 Key word solver

◇SOLVEUR =

This key word factor is optional: it makes it possible to choose another solver of resolution of system.

This operand is common to all the global commands [U4.50.01].

## 3.7 Operand TITER

◇TITER = title

Titrate that one wants to give to result stored in temp data structure of the evol\_ther type [U4.03.01].

## 4 Modelization

the problems of nonlinear thermal out of mobile coordinate system and under condition of stationarity can be treated with models using the finite elements 3D or 2D plane described in the documents [U3.23.01] and [U3.24.01].

## 5 Examples

One presents below the principal commands used to carry out a nonlinear computation of thermal out of mobile coordinate system and under condition of stationarity.

```
conduc=DEFI_FONCTION      (      NOM_PARA=' TEMP',
                           VALE=      ... )

enthal=DEFI_FONCTION     (      NOM_PARA=' TEMP',
                           VALE=      ... )

mat=DEFI_MATERIAU       ( THER_NL=_F      ( LAMBDA=conduc      ,
                                           BETA=enthal      ), )

...

chavi=CRÉA_CHAMP        ( MAILLAGE=mail      , TYPE_CHAM=' NOEU_DEPL_R',
                           AFFE=      _F (      TOUT=' OUI',
                           NOM_CMP=      ("DX", "DY"),
                           VALE_R=      (1.0, 0.0))

char=AFFE_CHAR_THER     ( MODELE=model      ,
                           FLUX_REP=_F      (      GROUP_MA=sou      ,
                           FLUN=5.E6      ),
                           CONVECTION=_F ( VITESSE=chavi      ))

tempe=THER_NON_LINE_MO  ( MODELE=model      ,
                           CHAM_MATER=chmat      ,
                           EXCIT=_F      (CHARGE=char      ),
                           )

...
```