MOUSE

PIPE DESIGN

User Guide

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1 PIPE DESIGN

The MOUSE Pipe Design Module is a tool, which makes it fast and easy to design pipe diameters for new systems as well as for pipes in existing systems. The basis for the design can be a rough input of a new system with geometric information about where the pipes should be and initial values for diameter and roughness (material) or it can be an existing MOUSE model for a complex system where some pipes should be re-designed.

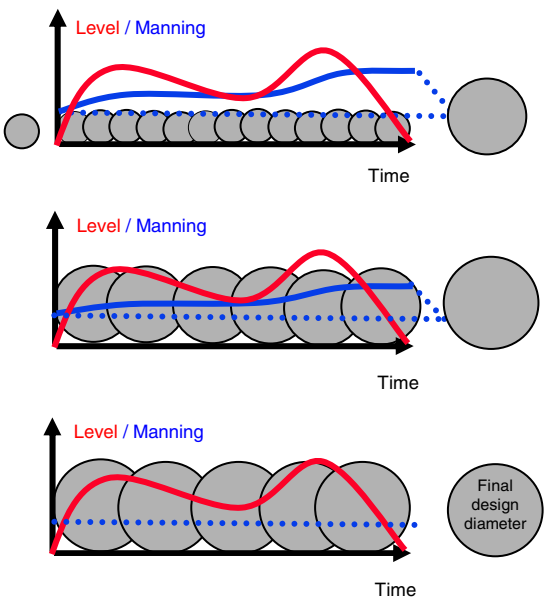
In both cases the design module will be an excellent help to speed up the process by designing the exact pipe sizes which is needed to fulfil the design criteria and to finally verify that the design system is correctly designed.

However it should be stressed that pipe design is an iterative process, and it is therefor recommended to use the feature on models of moderate size in order to be able to make the necessary number of iterations.

1.1 Design Principles

The design is based on an iterative process, where pipe diameters are changed in order to fulfil the specified design criteria. During each iteration the diameter is kept constant, but the Manning number is changed (increased) during simulation if the criteria is not fulfilled.

In the present version the pipes are always designed from the principle of increasing the diameter until the maximum level upstream in the system is below the design criteria. Thus the module cannot be used to design pipes from downstream criteria.



After end of the simulation the maximum Manning number is used to calculate the new diameter which will then be used in next iteration.

This means that after a number of iteration - depending on how good the initial choice of diameters was - the module will stabilise results on the diameters needed to fulfill the design criteria.

Each pipe (group) is designed independent of the others, which means that the process can be long of there are many pipes, since changing of one diameter can often influence the design of both upstream and downstream pipes.

1.2 Design Input

In the present version input data for the Pipe Design Module are specified in the Additional Parameters File (ADP). In order to activate the design module the simulation is started in the usual way after specification of the ADP file name on the Start Simulation Dialog, but an additional dialog for viewing and editing the design data will be available in parallel to the MOUSE Simulation Launcher.

The format of the DESIGN section in the ADP file is as follows:

Keyword	No	Parameter	Description
UNIT_TYPE	1	UNITTYPE	Specifies the unit type. 1 – SI, 2 – US
DESIGNRESULTFILE	1	"RESULTFILE"	File containing the history of the individual diameters. If present at simulation start a continuance of the previous iterations is assumed.
DESIGN CONSTANTS	1-6	DC1-DC6	Parameters for internal use. Not mandatory.
MANNINGITEM	1	DESIGNID	DesignID is used to identify the actual design group, but has no influence on the simulations.
	2	DESIGNTYPE	1 – Fixed Invert levels for pipes 2 – Fixed Top levels for pipes
	3	DESIGNCRITERIATYPE	1 – Critical Levels (specified at node dialog) 2 – Filling Degree (value specified as parameter 10 FILLINGDEGREE)
	4	DESIGNGROUPTYPE	1 – Group. All pipes are resized in parallel based on criteria in one node (value specified as parameter 6 "UPSTREAMNODE") 2 – Individual Pipes. Each pipe is designed based on criteria in the immediate upstream node.
	5	ELEMENTS	LSE-file specifying the group of links to be designed
	6	UPSTREAMNODE	Upstream node where design criteria is evaluated. Only used for DESIGNGROUPTYPE = 1
	7	MIN	Minimum value of the manning number. Note that extreme low values can cause numerical problems during the simulation. Its recommended to use values relatively close to the original value and run a few more itterations instead.
	8	MAX	Maximum value of the manning number. Note - se above.
	9	LOWERLIMIT	Limit for evaluating the design criteria. Specified relative the design criteria.
	10	FILLINGDEGREE	Filling degree. Only used for DESIGNCRITERIATYPE=2
Diameter Subtarget [Commercial_Pipes]	1	DIAMETER	List of commercial diameters. The diameters are not mandatory and should be given in ascending order. For UNIT_TYPE = 1 the unit is mm and for UNIT_TYPE = 2 the unit is in.

1.2.1 Example of ADP-file

```
[DESIGN]
  DESIGNRESULTFILE = 'MyOwnResults.txt'
  MANNINGITEM = 'Manning', 1, 1, 2, 'SelectedPipes.lse', '', 50, 200, -0.05, 1.0

  [Commercial_Pipes]
    Diameter = 50
    Diameter = 100
    Diameter = 200
  EndSect  // Commercial_Pipes

EndSect // DESIGN
```

1.2.2 Design Type

There are two design types available for designing pipes – fixed invert of pipes and fixed top of pipes.

When **fixed invert levels** are selected the network geometry is updated only with pipe diameters hence all invert levels are kept as in the original setup.

When **fixed top levels** are selected the top of each pipe is fixed, which means that all invert levels need to be updated according to the new diameters. All adjacent pipes are unchanged, hence when a nodes invert level is changed any attached pipe which was previously connected at the invert level of the manhole is now connected above invert of the manhole - at the original invert level of the manhole. A node invert level is never changed to a higher level than for the original setup.

Note: In the present version fixed top levels can only be used for pipes connected to manholes in both ends. If either upstream of downstream node is specified as a basin, the pipe will be designed according to the principle of fixed invert levels, regardless of design type. This is necessary in order to accommodate for the complexity of changed basin geometry, weir levels, pump start-/stop levels etc. which will often be present in basin structures.

1.2.3 Design Criteria

The design tool accommodates two types of design criteria – critical levels and filling degree. When the **Critical Levels** are applied the pipes will be designed according to the critical level specified in the MOUSE nodes dialog.

The **Filling Degree** is in this case interpreted as the maximum water level in upstream node compared to the upstream pipe levels. E.g. if the filling degree is set to 0.8 the design criteria will be set as a water level corresponding to the pipe being filled 80% at the design node.

If more than one pipe is connected to the design node the lowest value for all connected pipes is applied in order to ensure that the criteria is fulfilled for all pipes.

1.2.4 Design Group Type

The pipes can be designed either as a group or at individual basis.

If the pipes are designed as a **group** there size will decrease or increase with the same factor in order to obtain the design criteria for one specified upstream node. This means that the pipe sizes will change with same percentage for all pipes.

When the design acts on **individual** pipes each pipe will initially be automatically assigned to a design node corresponding to their immediate upstream node. Here the upstream node is defined as the node connected to the highest end of the pipe from geometric point of view.

If more than one pipe is connected to the same upstream node they will automatically be grouped together and thereby maintain their relative sizes.

1.2.5 Lower Limit

During the designing simulation there will be long periods where the water levels are below the design level. In order to avoid that these periods influence too much on the new pipe diameters a lower limit for designing is specified. Hence when the water level is below this limit the design module will not try to resize the current pipe size until the level rises above the limit again.

The limit is defined relatively to the design criteria.

1.2.6 Commercial Diameters

Through the iterations the pipe design will suggest diameters without taking into account that only some diameters are actually manufactured. Specifying the available pipe diameters can be used to let the module select the most appropriate standard pipe after end of simulation.

The standard pipe diameters should be given in increasing order and in millimetres (or inches for US-units).

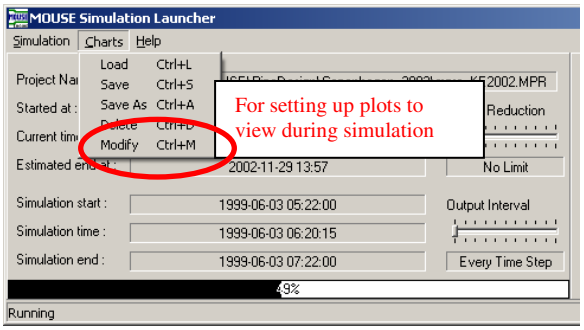
The commercial diameters are an optional input.

1.3 Design Simulation and output

In the present version all input data for the Pipe Design Module is specified in the Additional Parameters File (ADP). When the design module is in function the simulation is started the usual way (with specification of the ADP file name on the Start Simulation Dialog, but an additional dialog for viewing and editing the design data will be available in parallel to the MOUSE Simulation Launcher.

In the simulation launcher two new item types can be selected from the dialog <Charts>+<Modify>: Designs and Profiles.

- "Designs" are time series plots for the nodes where design criteria has been specified. The default selection will include actual level, critical level and calculated factor of the manning number which is changed during the simulation
- "Profiles" are longitudinal profiles. All profiles which are saved as LPF files can be selected

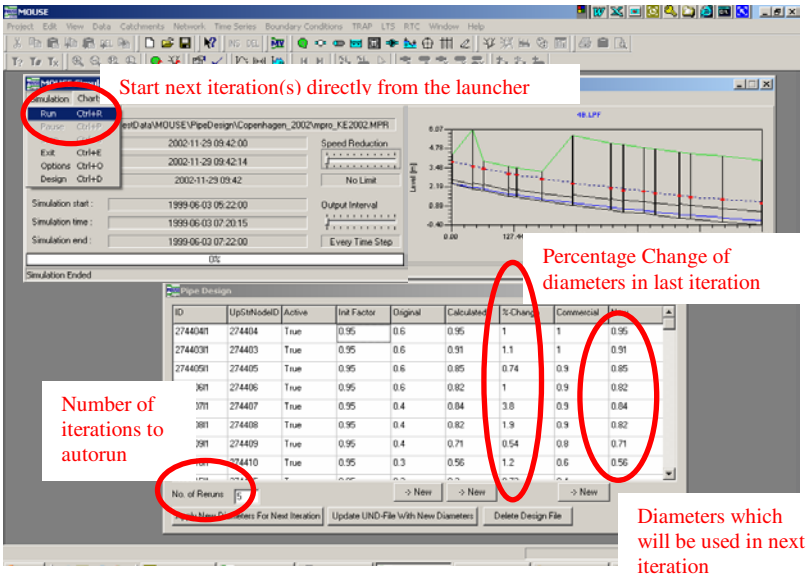


The additional dialog for pipe design is dominated by a grid with input parameters and results from the design, and can be used to adjust parameters for the design between the iterations.

The following information is available in the grid:

- ID — ID of the pipe
- UpStrNodeID — ID of the node where design criteria are evaluated
- Active — "True" if the pipe should actually be designed - can be used to exclude one or more pipes during some iterations.
- Init Factor — Initial factor of Manning number for next iteration - values smaller than 1.0 will allow the pipe to decrease in size if necessary, however too small values can cause numerical problems. Values bigger than 1.0 is usually not relevant since it will cause the pipe to increase in size even if it's not necessary. Default is 0.98.
- Original — Original diameter in mm.
- Calculated — Calculated diameter in mm - result from last iteration.
- %Change — Percentage change of diameter in last iteration
- Commercial — Smallest available commercial diameter which correspond to the calculated diameter
- New — Diameter in mm which will be used as initial value for next iteration. Default is that results from the previous iteration will be used

Below the columns Original, Calculated and Commercial it is possible to press "->New", which will simply copy the column of diameter to the column "New", thus cause them to be used as initial values for next iteration.



Number of reruns can be used to make a number of iterations automatically - default value is 1.

If changes are made in the grid these must be saved in order to be used for the next iteration. Saving can be done by pressing "Apply changes for next iteration", but if data has been changed and a new iteration started, a message will occur asking if the changes should be used or lost.

Finally there is the possibility to "Update UND file with new diameters" which will actually change the parameters in the model, or to "Delete design file" which will delete results of all the performed iterations and cause the design to start from scratch.