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DVS – DEUTSCHER VERBAND FÜR SCHWEISSEN UND VERWANDTE VERFAHREN E.V.	**Industrial piping made of thermoplastics** **Design and execution** **Above-ground pipe systems** **Calculation example**	DVS **Technical Code** **DVS 2210-1** **Supplement 1**

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Remarks: In order to keep the calculation example in compliance with the DVS 2210-1 technical code, the designations in **Section 4** and the corresponding preceding numbers have been completely incorporated into the supplement. The following overview shows the contents and systematic structure of the calculation example.

4.1 Hydraulic calculations
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4.1.4 Establishing the hydraulic losses
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1 Scope of application

The DVS 2210-1 technical code includes fundamentals for the design, calculation, prefabrication and assembly of industrial piping made of thermoplastics and laid above ground. **Section 4** of the technical code deals with calculations and stipulates the mathematical relationships (equations) for these.

In order to support the user of the technical code with regard to the practical use of the equations, Working Group W 4.3 a has decided to offer a worked example.

The scope of application of the worked example is restricted to that of the DVS 2210-1 technical code. Since the material chosen for the example is PP-H (Type 1), the results cannot be directly applied to other thermoplastics.

As far as the input data is concerned, the relevant values for other thermoplastics can be input into the equations as shown in this worked example. The user is responsible not only for the correct input of the material data, the characteristic values and the loading parameters but also for the interpretation of requirements.

2 Remarks about utilisation

The calculation steps are represented using columns and lines. The chosen order, with the input data and substance values specified first, is an example of what a calculation for a pipe system should look like.

As far as it is possible, the calculation operations are carried out strictly according to the order of the equations given in DVS 2210-1. In the cases where the information about the application of the equations is not fully comprehensive, supplementary footnotes or remarks have been inserted. For clarity, these remarks are highlighted.

2.1 Significance of the columns

2.1.1 "Section" column

This refers to the sub-sections in **Section 4** of the DVS 2210-1 technical code. If no numerical identification is specified in this column for a calculation line or an operation, the information is from another source, which is inserted instead.

2.1.2 "Equation no." column

This refers to the equation number given in DVS 2210-1 and gives a direct relationship with the input values and units.

Remark: In order to avoid any input errors, it is strongly recommended to carefully work through Section 4 in the DVS 2210-1 technical code.

2.1.3 "Index" column

This illustrates which operation is referred to in the calculation line concerned. The symbols are explained at the start of the calculation example.

2.1.4 "Subject" column

The main column gives the calculations as well as explanations and remarks. For clarity, the text is given in short form. If the description is not understood, it is recommended to look up details under the section number concerned in the DVS 2210-1 technical code.

Lines and pointers (arrows) have been inserted in some places at the right edge of the column. These give an indication of where connections exist between variables within a calculation section.

2.1.5 "Abbreviations" column

This refers to the abbreviations for equation parameters, dimensions, technical and physical variables and similar items. The meaning of each abbreviation is explained in **Section 11** of the DVS 2210-1 technical code.

Any abbreviations that have not been explained in the DVS 2210-1 technical code but are used for supplementary calculations are summarised in Section 2.2 below.

DVS, Technical Committee, Working Group "Joining of Plastics"

Orders to: DVS Media GmbH, P. O. Box 10 19 65, 40010 Düsseldorf, Germany, Phone: +49(0)211/1591-0, Telefax: +49(0)211/1591-150

Remark: With regard to the abbreviations used in DVS 2210-1 and in the calculation example, it should be noted that European standardisation has resulted in various amendments to the nomenclature. For example, de is written for the outside diameter of a pipe instead of da and e for the wall thickness instead of s.

However, the main purpose of the worked example is to provide the user with assistance rather than ensure that it conforms to the latest nomenclature. It is left to the user of the DVS 2210-1 technical code and of the calculation example in Supplement 1 to revise the abbreviations as necessary.

2.1.6 "Input or result" and "Unit" columns

These columns are self-explanatory since they include the essential contents of the calculation. It is important for the user to pay attention to the units of the input variables when inputting the values into the equation or ancillary calculations concerned. Information about this is included in the remarks about the equations in the DVS 2210-1 technical code.

2.2 Abbreviations and their explanation

The calculation example includes abbreviations that have already been explained in Section 11 in the DVS 2210-1 technical code. New terms that have been added and cannot be explained by the text are listed below.

Symbol/ abbreviation	Unit	Designation
empf	–	Recommended variable
erf	–	Necessary variable
geo	m	Geodetic
rechn	–	Computational variable
vorh	–	Existing variable
n	pieces	Number
q	N/m (N/mm)	Specific weight loads
Δ	–	Difference
Indices		
F		Guide
LA		Linear distance
LD		Service life
Z		Supply line

Explanations:

1) Unless any information is provided about the loading cycles, the maximum operating temperature must be taken into account during the dimensioning.

2) To define the characteristic material values.

3) Including the additional length of U compensators since their dimensions must be determined by calculation.

3 Calculation example

Basis: DVS 2210-1 technical code (04/97 edition)

General data:

Pipe system: Piping laid above ground in a plant building

Material: PP-H (Type 1)

Representation of the piping course: See the isometric drawing in the appendix

Operating loads:

Transported substance: Chemical waste water with low solvent proportions

Maximum operating temperature:	max T_B	40	°C
Minimum operating temperature:	min T_B	20	°C
Computational operating temperature[1]:	rechn T_B	40	°C
Computational temperature difference:	$\Delta\vartheta$	20	K
Computational service life[2]:	t_{LD}	25	years

Hydraulic data for the pipe system:

Feed pressure of the pumps:	p	4.0	bar
Feed volume per pump:	V'_z	40	m^3/h
Number of pumps:	n_p	3	
Flow volume of the pipe system:	V'	120	m^3/h

Geometrical data for the pipe system:

Pipe system length according to the isometric drawing in the appendix[3]:	ges L_R	1,[illegible]0	m
Max. height difference between the pump and pipe axes:	geod H	[illegible].0	m
Number of pipe bends in the main line:	n_{RF}	27	
Number of supply lines (T pieces), nominal width of the supply lines = DN 100:	n_{RF}	3	
Number of reducers:	n_{RF}	0	
Number of welds:	n_{RV}	275	
Number of shut-off valves (diaphragm valves):	n_{RA}	3	
Number of check valves:	n_{RA}	3	

Laying-specific data for the pipe system:

Distances between the pipe supports in the building:	L_A	2,000	mm
Pipe length with free expansion into the sewage treatment basin:	L_Δ	49	m
Pipe length with compensation using U bends:	L_Δ	380	m
Axial clamping of the pipe between fixed points:	In part		
Permissible loads on the fixed points in the line section on a steel structure:	zul F_{FP}	10	kN
Mean laying temperature (assembly temperature):	T_M	20	°C
Joining process:		Heated tool butt welding	

Substance values:

Density of the transported substance (weight $\gamma = \rho \cdot g$ [N/m^3]):	ρ	1,000	kg/m^3
Kinematic viscosity of the transported substance:	ν	1.00E-06	m^2/s