Combustion Heat of Insulating Materials of Cables and Wires

Leaflet for the Calculation of Fire Loads

1 General

The fire load is determined in accordance with the following tables specifying the combustion heat of insulating materials of electrical cables and wires per running metre.

The combustion heat values have been agreed in a workgroup with the specialist association “Cables and insulated wires” of the Zentralverband der Elektrotechnischen Industrie e.V. (ZVEI – German electrical and electronics industry association) and foreign manufacturers.

Cables and wires of different brands with the same designations can have different proportions of insulating material. The combustion heat of halogenated and halogen-free cables and wires with improved resistance in the case of fire is almost identical. However, halogen-free cables and wires with improved resistance in the case of fire mainly have the following advantages:

- low-smoke combustion, minor impairment of escape routes and of fire fighting operations and minor contamination of rooms and their contents;
- lower flammability, after removal of ignition source cables and wires stop burning within few seconds, whereas cables and wires with PVC or VPE insulation keep burning after removal of ignition source
- minor fire spread due to more favourable fire behaviour

2 Application

The combustion heat can be the basis for calculating the fire load in accordance with VdS CEA 4001 Cl. 4.1.1 n)[1].

They are also an appropriate guidance for calculations in accordance with DIN 4102-4 “Fire behaviour of building materials and building components”, Cl. 6.5.1.2 [2].

3 Application of tables

The cables and wires are distinguished according to:

- construction types;
- insulating materials;
  - halogenated;
  - halogen-free;
- nominal cross section of the conductors;
- number of conductors.

Depending on the form and type of construction, different quantities of insulating material are required. In Table 1 the most current cable and performance types are listed, specifying their cross sections and number of conductors.

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[1] Clause 4.1.1.n) in VdS CEA 4001en: false ceiling spaces and false floor spaces < 0,8 m (see Cl. 5.4) which are not separated by non-combustible materials and in which the false ceilings and floors themselves are made of non-combustible materials; provided that in these areas no materials of high flammability are available, and the fire load of materials of low flammability (e.g. cables, insulating material) does not exceed 12,6 MJ/m² (3,5 kWh/m²); in areas of high cable concentration the fire load per 4 m x 4 m shall not exceed 335 MJ (93,1kWh). It is important to ensure that the fastening of the false ceiling construction is resistant enough, and that any penetrations to (vertical) cable ducts are sealed with non-combustible materials. The same applies to false ceiling spaces such as described above, however with a false ceiling made of combustible materials, provided that this ceiling is separated from the intermediate space at least by a highly fire-retardant separation. If false ceiling and false floor spaces less than 300 mm high do not comply with the a.m. conditions, they shall be divided into fields of less than 100 m² by means of fire-retardant components made of non-combustible materials.

Note
The values can be converted as follows:

– 1 MJ/m² corresponds to 0,278 kWh/m²
– 1 kWh/m² corresponds to 3,6 MJ/m²

[2] Cl. 6.5.1.2: The specifications of 6.5 do not apply to a fire load of the false ceiling area, therefore they do not apply to a classification of the false ceilings in case of a fire load from above.

Therefore, the specifications imply that there are no combustible materials in the false ceiling area between the raw and the false ceiling, except for the parts belonging to the false ceiling construction.

Cable insulations or materials whose fire load is evenly spread and < 7 kWh/m² are also considered unobjectionable.

In case of cable bundles, pipe insulations, wires, insulation layers etc. consisting of components of material class B with a fire load > 7 kWh/m², or in case the false ceiling with fire load from above is to be classified in a fire resistance class, the suitability of the false ceilings shall be verified by tests in accordance with DIN 4102-2 : 1977-09, Cl. 4.1, 6.2.2.5 and 7.2.1.

Table 1: Combustion heat of cables and wires with nominal voltages up to 1000 V

Dimensions of cables and wires		Design of cables and wires				
		halogenated			halogen-free	
Number of conductors and nominal cross section		NYM	NYY	NYCY/ NYCWY	NHXHX	NHXCHX
n mm²	n mm² mm²	kWh/m				
1 x 1,5		0,17				
1 x 2,5		0,22	0,22		0,22	
1 x 4		0,25	0,33		0,28	
1 x 6		0,28	0,33		0,28	
1 x 10		0,36	0,33		0,28	
1 x 16		0,42	0,42		0,39	
1 x 25		0,58	0,58		0,53	
1 x 35			0,67		0,58	
1 x 50			0,81		0,69	
1 x 70			0,92		0,81	
1 x 95			1,17		1,03	
1 x 120			1,31		1,14	
1 x 150			1,58		1,39	
2 x 1,5		0,42	0,69		0,69	
2 x 2,5		0,53	0,78		0,78	
2 x 4		0,67	1,00		0,89	
2 x 6		0,75	1,11		1,00	
2 x 10		1,17	1,31		1,19	
3 x 1,5		0,44	0,75		0,78	
3 x 2,5		0,58	0,83		0,86	
3 x 4		0,72	1,08		1,00	
3 x 6		0,92	1,22		1,08	
3 x 10		1,28	1,42		1,28	
3 x 16		1,53	1,69		1,53	
3 x 25		2,39	2,47		2,25	
3 x 35		2,78	2,14		2,56	
3 x 50			2,60		3,19	
3 x 70			3,08		3,94	
3 x 95			4,06		5,14	
3 x 120			4,47		5,89	
3 x 150			5,42		7,25	
4 x 1,5	3 x 1,5/1,5	0,53	0,83	0,78	0,89	0,78
4 x 2,5	3 x 2,5/2,5	0,67	0,94	0,86	1,00	0,89
4 x 4	3 x 4/4	0,92	1,25	1,11	1,14	1,00
4 x 6	3 x 6/6	1,08	1,42	1,25	1,28	1,11
4 x 10	3 x 10/10	1,50	1,67	1,47	1,50	1,33

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Number of conductors and nominal cross section		NYM	NYY	NYCY/ NYCWY	NHXHX	NHXCHX
n mm²	n mm² mm²	kWh/m				
4 x 16	3 x 16/10	1,86	2.03	1,75	1,86	1,58
	3 x 16/16			1,75		1,58
4 x 25		2,89	2,89		2,64	
	3 x 25/16		2,67	2,53	2,42	2,31
	3 x 25/25			2,53		2,31
4 x 35		3,28	2,61		3,00	
	3 x 35/16		2,67	2,22	2,69	2,61
	3 x 35/35			2,22		2,61
4 x 50			3,31		3,92	
	3 x 50/25		3,31	2,78	3,53	3,33
	3 x 50/50			2,78		3,33
4 x 70			4,08		4,81	
	3 x 70/35		4,06	3,28	4,31	4,11
	3 x 70/70			3,28		4,11
4 x 95			5,11		6,25	
	3 x 95/50		5,19	4,28	5,58	5,33
	3 x 95/95			4,28		5,33
4 x 120			5,69		7,14	
	3 x 120/70		5,81	4,72	6,58	6,11
	3 x 120/120			4,72		6,11
4 x 150			6,97		7,14	
	3 x 150/70		7,03	5,72	7,64	7,50
	3 x 150/150			5,72		7,50
5 x 1,5	4 x 1,5/1,5	0,58	0,94	0,86	1,03	0,89
5 x 2,5	4 x 2,5/2,5	0,75	1,08	0,97	1,14	1,03
5 x 4	4 x 4/4	1,11	1,44	1,28	1,31	1,17
5 x 6	4 x 6/6	1,28	1,64	1,44	1,47	1,31
5 x 10	4 x 10/10	1,83	2,00	1,69	1,83	1,53
5 x 16	4 x 16/16	2,31	2,39	2,08	2,17	1,89
5 x 25	4 x 25/16	3,42	3,42	2,92	3,14	2,69
	4 x 35/16			2,67		3,06
	4 x 50/25			3,44		4,00
	4 x 70/35			4,17		4,89
	4 x 95/50			5,33		6,44
	4 x 120/70			5,94		7,36
	4 x 150/70			7,22		8,97
6 x 1,5		0,67				
7 x 1,5		0,67	1,08		1,17	
7 x 2,5			1,22		1,31	
7 x 4			1,67		1,50	
12 x 1,5			1,56		1,69	
12 x 2,5			1,78		2,00	
12 x 4			2,53		2,31	
19 x 1,5			2,06		2,36	
19 x 2,5			2,44		2,69	
19 x 4			3,42		3,14	
24 x 1,5			2,56		2,86	
24 x 2,5			2,94		3,28	
24 x 4			4,33		3,97	
37 x 1,5			3,39		3,92	
37 x 2,5			4,00		4,69	
37 x 4			6,03		5,53	

Table 2: Combustion heat of wires for telecommunication and data processing systems

Dimensions of wires			Construction type of wires			
			halogenated		halogen-free	
Number of conductors & nominal diameter			I-YY Bd	IE-Y(ST) Y Bd	I-HH Bd	IE-H(ST) H Bd
n	n	mm	kWh/m			
2 x	2 x	0,6	0,11		0,22	
4 x	2 x	0,6	0,17		0,33	
6 x	2 x	0,6	0,22		0,39	
10 x	2 x	0,6	0,28		0,53	
16 x	2 x	0,6	0,39		0,81	
20 x	2 x	0,6	0,44		0,97	
24 x	2 x	0,6	0,50		1,11	
30 x	2 x	0,6	0,67		1,36	
40 x	2 x	0,6	0,81		1,72	
50 x	2 x	0,6	0,94		2,00	
60 x	2 x	0,6	1,17		2,39	
80 x	2 x	0,6	1,42		3,06	
100 x	2 x	0,6	1,69		3,72	
2 x	2 x	0,8		0,19		0,28
4 x	2 x	0,8		0,28		0,39
8 x	2 x	0,8		0,42		0,58
12 x	2 x	0,8		0,58		0,86
16 x	2 x	0,8		0,72		
20 x	2 x	0,8		0,83		1,17
24 x	2 x	0,8		0,94		
28 x	2 x	0,8		1,17		
32 x	2 x	0,8		1,28		1,78
36 x	2 x	0,8		1,39		
40 x	2 x	0,8		1,50		2,08
44 x	2 x	0,8		1,61		
48 x	2 x	0,8		1,83		
52 x	2 x	0,8		1,94		
56 x	2 x	0,8		2,06		
60 x	2 x	0,8		2,14		
64 x	2 x	0,8		2,25		
68 x	2 x	0,8		2,36		
72 x	2 x	0,8		2,47		
76 x	2 x	0,8		2,72		
80 x	2 x	0,8		2,83		

Table 3: Combustion heat of cables with nominal voltages exceeding 1000 V

Dimensions of cables			Design of cables			
			halogenated		halogen-free	
Number of conductors & nominal cross section			NA2xSEY	NYSEY		
n		mm^2 mm^2	kWh/m			
3	x	35/16	10,28	10,56		
3	x	50/16	11,67	11,67		
3	x	70/16	13,06	12,78		
3	x	95/16	14,72	14,72		
3	x	120/16	16,68	16,12		

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