

APPLICATION NOTE

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Conversion tables between HVL and Total Filtration

This application note contains a conversion table and a description of how HVL can be transformed into total filtration and the reverse. The conversion is valid for DC. The conversions are used by Piranha and Barracuda MPD when calculating HVL or total filtration.



Introduction

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The Piranha and the Barracuda MPD use transfer polynomials for conversion between the two quantities HVL and total filtration. By measuring one of them, the other can be calculated. All systems that are calibrated for Radiographic range have this functionality. It is possible to perform conversions from 40 kV up to 150 kV.

Calculations and Measurements

For the derivation of the polynomials the software Spectrum Processor distributed by IPEM (CD-Rom Edition 1997 ISBN 0904 181 88 X) was used. The software requires you to enter the kVp, total filtration, anode material and angle, and ripple and it then calculates the HVL.

In the RTI software we have chosen to base the HVL and total filtration calculations on an anode angle of 14 degrees since it is the most common anode angle in diagnostic X-ray equipment. Therefore the measured results can differ from true values when doing measurements on therapy or industrial X-ray equipment which may have other anode angles.

In table 1 the HVL for different anode angles are shown.

80 kV and a total filtration of 3 mm Al	
Anode angle (degrees)	HVL (mm Al)
8	3,47
10	3,29
14	3,05
18	2,92

Table 1. The HVL due to difference in anode angle.

Table 2a and 2b shows the calculated HVL at different kV and filtration.

Total filtration	HVL							
	35 kV	40 kV	50 kV	60 kV	70 kV	80 kV	90 kV	100 kV
1	0,72	0,83	1,05	1,26	1,48	1,74	2,02	2,32
1,5	0,89	1,04	1,31	1,55	1,81	2,10	2,42	2,77
2	1,04	1,22	1,53	1,82	2,12	2,44	2,80	3,17
2,5	1,16	1,37	1,74	2,07	2,40	2,76	3,15	3,55
3	1,27	1,50	1,92	2,29	2,65	3,05	3,47	3,90
3,5	1,36	1,62	2,08	2,49	2,89	3,31	3,76	4,21
4	1,44	1,72	2,23	2,68	3,10	3,56	4,04	4,51
4,5	1,51	1,81	2,36	2,85	3,31	3,79	4,29	4,78
5	1,57	1,90	2,49	3,01	3,49	4,01	4,53	5,03
5,5	1,63	1,97	2,60	3,15	3,67	4,21	4,75	5,26
6	1,68	2,04	2,70	3,29	3,83	4,39	4,95	5,48
7	1,78	2,17	2,89	3,53	4,12	4,73	5,32	5,87
8	1,87	2,29	3,06	3,75	4,38	5,03	5,64	6,21
10	2,02	2,49	3,35	4,12	4,82	5,54	6,19	6,78
15	2,26	2,83	3,91	4,85	5,67	6,49	7,21	7,83
20	2,43	3,07	4,28	5,36	6,31	7,20	7,96	8,60
25			4,57	5,72	6,76	7,74	8,52	9,18
30				6,04	7,10	8,12	8,92	9,58
35					7,43	8,42	9,23	9,91
40						8,73	9,56	10,25

Table 2a. Conversion tables between HVL and total filtration. The tables are valid for DC, a anode made of tungsten, no ripple, and with an angle of 14 degrees.

Total filtration	HVL							
	110 kV	120 kV	125 kV	130 kV	135 kV	140 kV	145 kV	150 kV
1	2,65	3,01	3,19	3,38	3,57	3,77	3,96	4,17
1,5	3,13	3,50	3,70	3,90	4,09	4,30	4,50	4,71
2	3,56	3,96	4,16	4,37	4,57	4,78	4,98	5,19
2,5	3,96	4,38	4,59	4,79	5,00	5,22	5,43	5,64
3	4,33	4,76	4,97	5,19	5,40	5,61	5,83	6,04
3,5	4,66	5,10	5,32	5,54	5,76	5,98	6,19	6,40
4	4,97	5,42	5,65	5,87	6,09	6,31	6,52	6,74
4,5	5,25	5,72	5,94	6,17	6,39	6,61	6,82	7,04
5	5,52	5,98	6,21	6,44	6,66	6,88	7,10	7,31
5,5	5,76	6,23	6,46	6,69	6,91	7,13	7,35	7,56
6	5,98	6,46	6,69	6,92	7,14	7,36	7,58	7,79
7	6,38	6,86	7,10	7,32	7,54	7,76	7,98	8,19
8	6,73	7,21	7,45	7,67	7,89	8,11	8,32	8,53
10	7,31	7,79	8,02	8,25	8,46	8,68	8,89	9,09
15	8,37	8,85	9,08	9,30	9,52	9,73	9,93	10,13
20	9,16	9,66	9,90	10,12	10,35	10,56	10,77	10,97
25	9,75	10,27	10,51	10,74	10,98	11,20	11,41	11,62
30	10,17	10,69	10,93	11,17	11,40	11,62	11,84	12,05
35	10,49	11,02	11,27	11,52	11,75	11,97	12,20	12,41
40	10,85	11,40	11,67	11,92	12,16	12,40	12,63	12,85

Table 2b. Conversion tables between HVL and Total Filtration. The tables are valid for DC, a anode made of tungsten, no ripple, and with an angle of 14 degrees.

Results

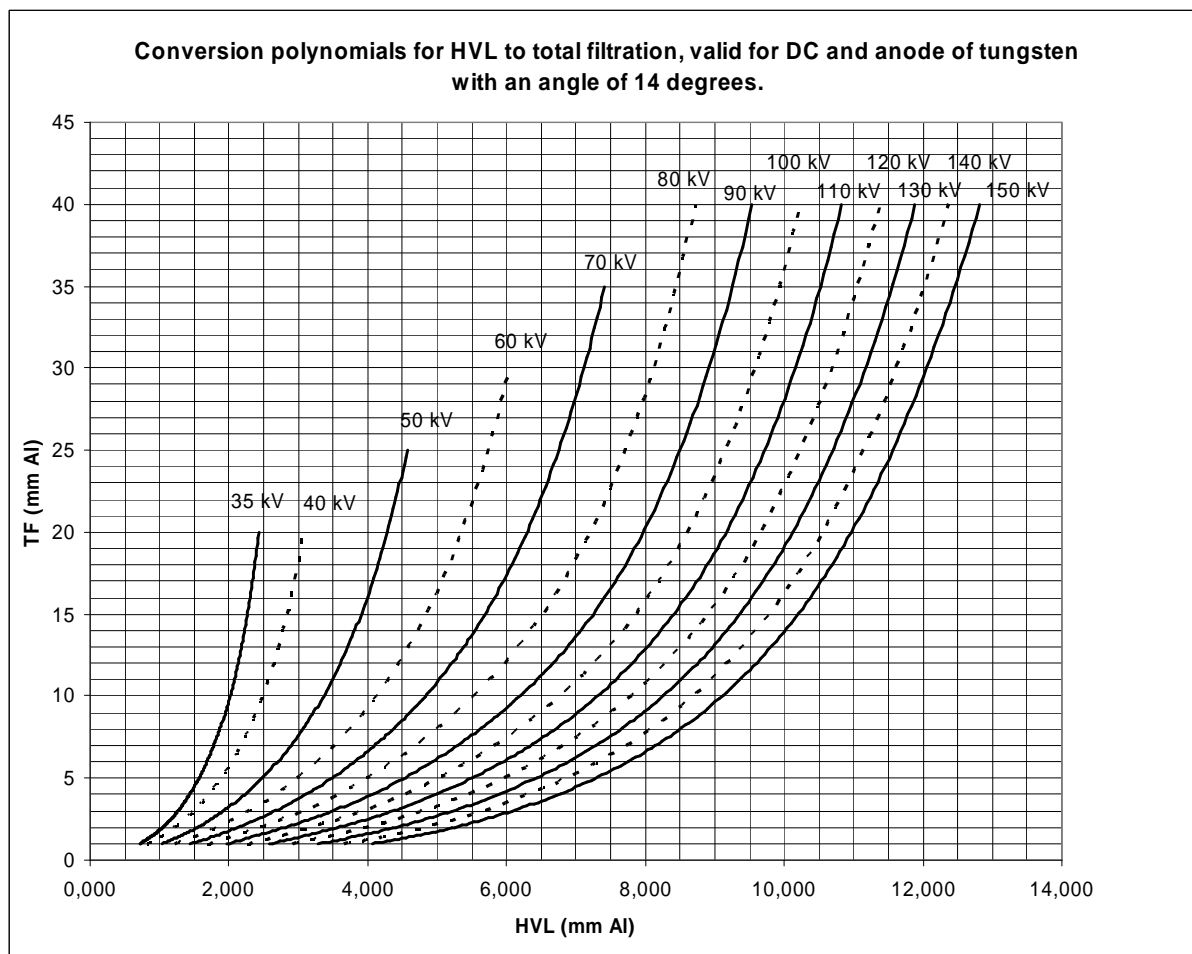


Figure 1. The conversion polynomials for HVL to total filtration corresponding to the values in table 2a and 2b. The graph is valid for a tungsten anode with 14 degrees of angle.

By reversing the axis, polynomials you can also get the total filtration by knowing the HVL and kV.

The polynomials of the different kV-values have been implemented in the RTI software which enables an automatic calculation of HVL or total filtration.

The inaccuracy in estimated total filtration is $\pm 10\%$ or ± 0.3 mm and the inaccuracy in estimated HVL is $\pm 10\%$ or ± 0.2 mm. The new polynomials give values that are well within these margins of error.

Calculations of polynomials corresponding to other anode angles can easily be acquired using the same program i.e. Spectrum Processor.