Physical Compression Test

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In order to conduct the physical test, samples of 90 ppi foam of circular cross-sectional area (1" diameter and 1" depth) were used. First, a trial using four samples was conducted. The four pieces of foam were placed on a level table and even spaced underneath a plastic beaker such that all four pieces were entirely covered. Water was gradually added to the beaker until slight compression was noticeable. This minimum water volume was recorded. Water was then continuously added to the beaker again until full compression occurred. This maximum water volume was also recorded. Similar experiments following the same procedure were conducted once using two pieces of foam and three times using one piece of foam.

Note: It was important to record the maximum water volume as the point where the foam first reaches 100-percent compression.

Using the recorded volume of water and the specific density of water, the mass of the water can be calculated (using density = mass / volume). By including the mass of the cylinder itself, the total mass on top of the foam can be found. Using gravity, the total force pushing down on the foam samples can be determined (using force = mass x gravity). One can then easily find the total pressure on all foam pieces (using the equation total pressure = force / total cross sectional area). Consequently, the pressure one one foam piece can be calculated by dividing total pressure by the number of foam samples.

The subsequent calculations conducted for each trial determine both the minimum pressure required to trigger foam compression and maximum pressure to reach full compression. A full discussion of these calculations can be viewed in the Foam Compression (Physical) Test MathCAD file. Results from the five total experiments are summarized below.

Summary of Results

Ideally, the resulting min. and max. pressures for one piece of foam found from each of the trials should be the same, as the pressures that trigger the beginning of compression and result in full compression should be the same for each sample of foam. However, as seen in the results in the table below, some discrepancies between pressure values do occur.

These discrepancies may be a result of the foam dimensions. The foam was punched into cylindrical shapes manually and therefore, may not exactly be 1" in diameter and 1" in depth; some may have larger diameters and some may have smaller diameters due to skewed punching. The process of picking samples to use for different physical experiments was random. Therefore, the results should be generally centered around the theoretical pressure values. Additionally, the process of determining minimum versus maximum compression values may not have been consistent. There was no standard gauge used to signal when x-percent compression occurred. We were therefore forced to determine visually when both 1-percent (minimum) and 100-percent (maximum) compression had occurred. Of course, using vision only is not a very precise method.

The average pressure found to trigger compression is approximately 1.25kPa, whereas the average pressure found to achieve full compression is approximately 3.00kPa.

Determination of Force and Pressure on Foam:

		Exp. With One Piece	*Exp. With Two Pieces*	*Exp. With Four Pieces*
Start of Compression	Weight of Water	0 g	124 g	257 g
	Total Weight	53.67 g	177.67 g	310.67 g
	Total Force	.526 N	1.742 N	3.047 N
	Pressure on One Piece	1.039 kPa	1.719 kPa	1.503 kPa
End of Compression	Weight of Water	99 g	282 g	550 g
	Total Weight	152.67 g	335.67 g	603.67 g
	Total Force	1.497 N	3.292 N	5.92 N
	Pressure on One Piece	2.955 kPa	3.248 kPa	2.921 kPa

Experiment with One Piece

		Trail One	*Trial Two*	*Trial Three*
Start of Compression	Weight of Water	0 g	0 g	0 g
	Total Weight	53.67 g	53.67 g	53.67 g
	Total Force	.526 N	.526 N	.526 N
	Pressure on One Piece	1.039 kPa	1.039 kPa	1.039 kPa
End of Compression	Weight of Water	99 g	101 g	97 g
	Total Weight	152.67 g	154.67 g	150.67 g
	Total Force	1.497 N	1.517 N	2.478 N
	Pressure on One Piece	2.955 kPa	2.993 kPa	2.916 kPa

It is important to determine if the pressure at collapse found using trials with the foam column and experimental apparatus is in between these minimum and maximum values determined using this physical compression test. If so, this confirms the general accuracy of the results shown above. With these min. and max. pressure values, we can design the point-of-use filtration unit to avoid failure by compression.