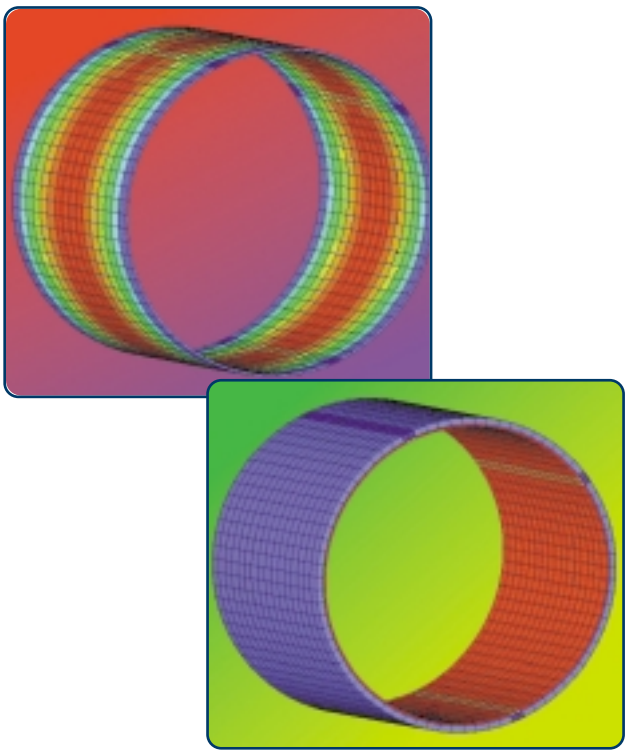
Design Engineering
Application Solutions

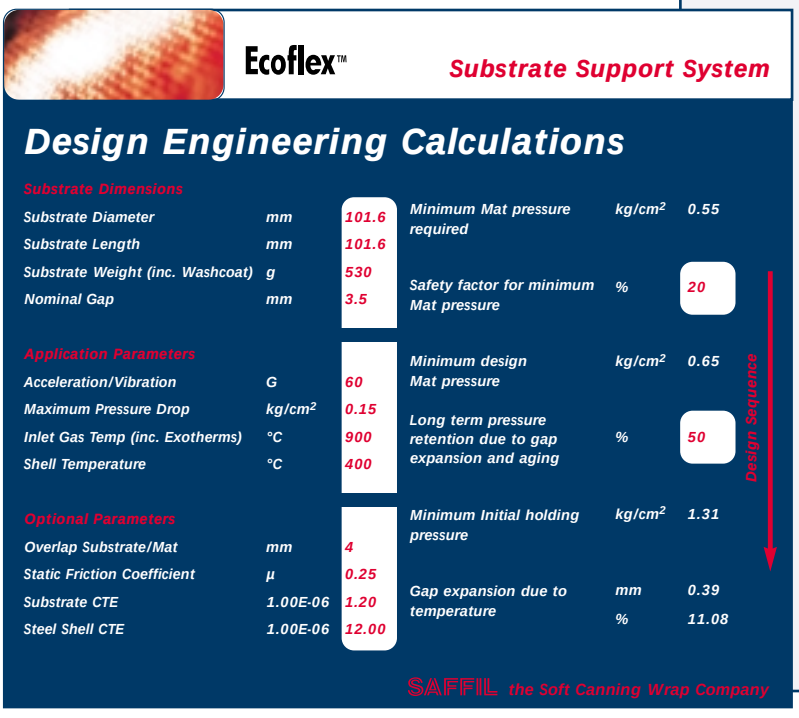
SAFFIL
Automotive

Ecoflex™

Design Engineering
Finite Element Analysis



Design Engineering Calculations



The Ecoflex technical team have developed a series of design guides and predictive modelling tools to provide engineered solutions for each application.

Finite Element Analysis (FEA) *modelling is used to simulate the performance of Ecoflex 200 as a catalyst substrate support system.*

FEA is technically the most cost effective method for determining support mat performance. This method takes into account the intrinsic variability of manufactured substrates, differing canned gap thickness and can be used for predicting skin temperatures, push out forces, pressure on substrates and inner can surface pressures.

Ecoflex Design Engineering Calculations *enable the initial selection of nominal gap or gap bulk density based on the thermo-mechanical needs of catalytic converter operation.*

The tool calculates the minimum and maximum holding force required to retain the substrate in the application taking into account G-forces, gas temperatures, external shell target temperatures and expansion effects.

These calculations enable Saffil Automotive to provide the optimum product solution based on both theoretical calculations and on accelerated lifetime testing. This approach is taken for each customer enquiry giving a tailored proposal.

These calculations are important in identifying the performance window between the isostatic strength of thin and ultra thin wall substrates and the holding forces required, especially in close coupled applications.

Designed for Lifetime

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Soft Canning Expertise

The Ecoflex Product Specification Tool helps to calculate gaps, basis weights, initial pressure performance and holding force data for Ecoflex products when with and without binder materials. This data can be generated for ambient and high temperature conditions. A statistical model shows the probability of each individual case when taking into account the stacked up tolerances of each individual component.

The required Gap Bulk Density (GBD) is calculated based on accumulated tolerances of the main parameters (outer diameter of substrate, inner diameter of steel shell, basis weight of Ecoflex wrap).

Ecoflex Product Specification Tool

Saffil Ecoflex™ 200

Project Data Overview

OD of substrate	101.6	mm	+/- 1.8	mm	3	Date	
ID of steel shell	109.6	mm	+/- 0.2	mm	3	Customer	
FBW of Ecoflex	1450	gsm	+/- 8	%	3	OEM	
BBW of Ecoflex	1595	gsm	(10% organics)		Sigma	Project	
Gas Temp (ºC)	950		CTE of ceramic substrate		1.2 *10e - 6	Calculated by	
Shell Temp (ºC)	460		CTE of steel shell		12 *10e - 6	Notice	

COLD	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Sub. OD (mm)	99.8	100.0	100.2	100.3	100.5	100.7	100.9	101.1	101.2	101.4	101.6	101.8	102.0	102.1	102.3	102.3	102.7	102.9	103.0	103.2	103.4
Shell ID (mm)	109.8	109.8	109.8	109.7	109.7	109.7	109.7	109.7	109.6	109.6	109.6	109.6	109.6	109.5	109.5	109.5	109.5	109.5	109.4	109.4	109.4
Gap (mm)	5.00	4.90	4.80	4.70	4.60	4.50	4.40	4.30	4.20	4.10	4.00	3.90	3.80	3.70	3.60	3.50	3.40	3.30	3.20	3.10	3.00
FBW (gsm)	1334	1346	1357	1369	1380	1392	1404	1415	1427	1438	1450	1462	1473	1485	1496	1508	1520	1531	1543	1554	1566
BBW (gsm)	1467	1480	1493	1506	1518	1531	1544	1557	1569	1582	1595	1608	1621	1633	1646	1659	1672	1684	1697	1710	1723
FGBD (g/cc)	0.27	0.27	0.28	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.39	0.40	0.43	0.43	0.45	0.46	0.48	0.50	0.52
BGBD (g/cc)	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.39	0.40	0.41	0.43	0.44	0.46	0.47	0.49	0.51	0.53	0.55	0.57
FP (kg/cm²)	0.89	1.03	1.16	1.29	1.43	1.43	1.60	1.77	1.94	2.25	2.48	2.68	2.88	3.28	3.59	4.21	4.52	5.11	5.68	6.24	6.93
CP (kp/cm²)	1.51	1.68	1.89	2.11	2.32	2.54	2.75	2.94	3.12	3.31	3.49	3.99	4.29	4.90	5.21	5.83	6.45	7.11	7.80	8.49	9.22

HOT	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Sub. OD (mm)	99.9	100.1	100.3	100.5	100.6	100.8	101.0	101.2	101.4	101.5	101.7	101.9	102.1	102.3	102.4	102.6	102.8	103.0	103.2	103.3	103.5
Shell ID (mm)	110.4	110.4	110.3	110.3	110.8	110.3	110.3	110.2	110.2	110.2	110.2	110.2	110.1	110.1	110.1	110.1	110.1	110.0	110.0	110.0	110.0
Gap (mm)	5.23	5.13	5.03	4.93	4.83	4.73	4.63	4.53	4.43	4.33	4.23	4.13	4.03	3.93	3.83	3.73	3.63	3053	3.43	3.33	3.23
FBW (gsm)	1334	1346	1357	1369	1380	1392	1404	1415	1427	1438	1450	1462	1473	1485	1496	1508	1520	1531	1543	1554	1566
BBW (gsm)	1467	1480	1493	1506	1518	1531	1544	1557	1569	1582	1595	1608	1621	1633	1646	1659	1672	1684	1697	1710	1723
FGBD (g/cc)	0.25	0.26	0.27	0.28	0.27	0.29	0.30	0.31	0.32	0.33	0.34	0.35	0.37	0.38	0.39	0.40	0.42	0.43	0.45	0.47	0.48
BGBD (g/cc)	0.28	0.29	0.30	0.31	0.31	0.32	0.33	0.34	0.35	0.37	0.38	0.39	0.40	0.42	0.43	0.44	0.46	0.48	0.49	0.51	0.53
FP (kg/cm²)	0.76	0.89	0.89	1.03	1.16	1.29	1.43	1.60	1.77	1.94	2.11	2.28	2.48	2.68	3.08	3.28	3.59	4.21	4.52	5.11	5.68
CP (kp/cm²)	1.34	1.34	1.51	1.68	1.89	2.11	2.32	2.54	2.75	2.94	3.12	3.31	3.68	3.99	4.29	4.90	5.52	5.83	6.45	7.11	7.80
DISTRIBUTION per Million Parts	0	4	37	278	1,607	7,093	23,906	61,507	120,802	181,118	207,296	181,118	120,802	61,507	23,906	7,093	1,607	278	37	4	0

Canning Calibration Tool

The Ecoflex Canning Calibration Tool

The Ecoflex Canning Calibration Tool is the ideal tool for non-calibrated systems or any system which uses calibration by selection. It may be used for risk analyses and help to design the application before going into actual laboratory testing. The statistical distribution of each outcome can be displayed.

Saffil Ecoflex™ 200

Initial Pressure Performance - Data Overview for Calibration by Selection

								Volume	
Substrate OD Tolerances		+/-	2	mm	6	Sigma		1 000 000	Date
Actual OD of Sub	100.0 mm	Min	98.0	mm	Max	102.0	mm	1 000 000	Customer
Calibrated Sub ODs	99.00 mm	Min	98.0	mm	Max	100.0	mm	500 000	OEM
Steel Shell ID Tolerances		+/-	0.2	mm	6	Sigma		1 000 000	Project
Actual ID of Shell	108.0 mm	Min	107.8	mm	Max	108.2	mm	1 000 000	Calculated by
Calibrated Shell IDs	107.90 mm	Min	107.8	mm	Max	108.0	mm	500 000	Notice
Ecoflex FBW Tolerances		+/-	8	%	6	Sigma		1 000 000	
Actual FBW	1800 gsm	Min	1620	mm	Max	1980	gsm	1 000 000	
Calibrated FBW	1700 00 gsm	Min	1600	mm	Max	1800	gsm	500 000	
Gas Temp (ºC)	950		CTE of ceramic substrate			1.2 *10e - 6			
Shell Temp (ºC)	460		CTE of steel shell			12 *10e - 6			

Ecoflex™

COLD	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
Sub. OD (mm)	98.00	98.10	98.20	98.30	98.40	98.50	98.60	98.70	98.80	98.90	99.00	99.10	99.20	99.30	99.40	99.50	99.60	99.70	99.80	99.90	100.00
Shell ID (mm)	108.00	107.99	107.98	107.97	107.96	107.95	107.94	107.93	107.92	107.91	107.90	107.89	107.88	107.87	107.86	107.85	107.84	107.83	107.82	107.81	107.80
Gap (mm)	5.00	4.95	4.89	4.84	4.78	4.73	4.67	4.62	4.56	4.51	4.45	4.40	4.34	4.29	4.23	4.18	4.12	4.07	4.01	3.96	3.90
FBW (gsm)	1600	1610	1620	1630	1640	1650	1660	1670	1680	1690	1700	1710	1720	1730	1740	1750	1760	1770	1780	1790	1800
BBW (gsm)	1760	1771	1782	1793	1804	1815	1826	1837	1848	1859	1870	1881	1892	1903	1914	1925	1936	1947	1958	1969	1980
FGBD (g/cc)	0.32	0.33	0.33	0.34	0.34	0.35	0.36	0.36	0.37	0.38	0.38	0.39	0.40	0.40	0.41	0.42	0.43	0.44	0.44	0.45	0.46
BGBD (g/cc)	0.35	0.36	0.36	0.37	0.38	0.38	0.39	0.40	0.41	0.41	0.42	0.43	0.44	0.44	0.45	0.46	0.47	0.48	0.49	0.50	0.51
FP (kg/cm²)	1.77	1.77	1.94	1.94	2.11	2.11	2.28	2.48	2.48	2.68	2.88	2.88	3.28	3.28	3.59	3.59	3.90	4.21	4.52	4.83	5.11
CP (kp/cm²)	2.75	2.75	2.94	3.12	3.12	3.31	3.49	3.49	3.49	3.99	4.29	4.29	4.60	4.90	5.21	5.52	5.52	5.83	6.14	6.45	6.76
DISTRIBUTION	Parts per category based on the volume of calibrated substrates																				500,000
	0	0	0	0	0	0	0	2	26	247	1,673	7,954	26,560	62,270	102,510	118,489	96,165	54,801	21,927	6,160	1,215

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