



Development and Testing of Faecal Sludge Simulants

Dr Konstantina (Tina) Velkushanova
L. Tartibu*, M. Rajan** and C. A. Buckley*

Pollution research group
University of KwaZulu-Natal, South Africa

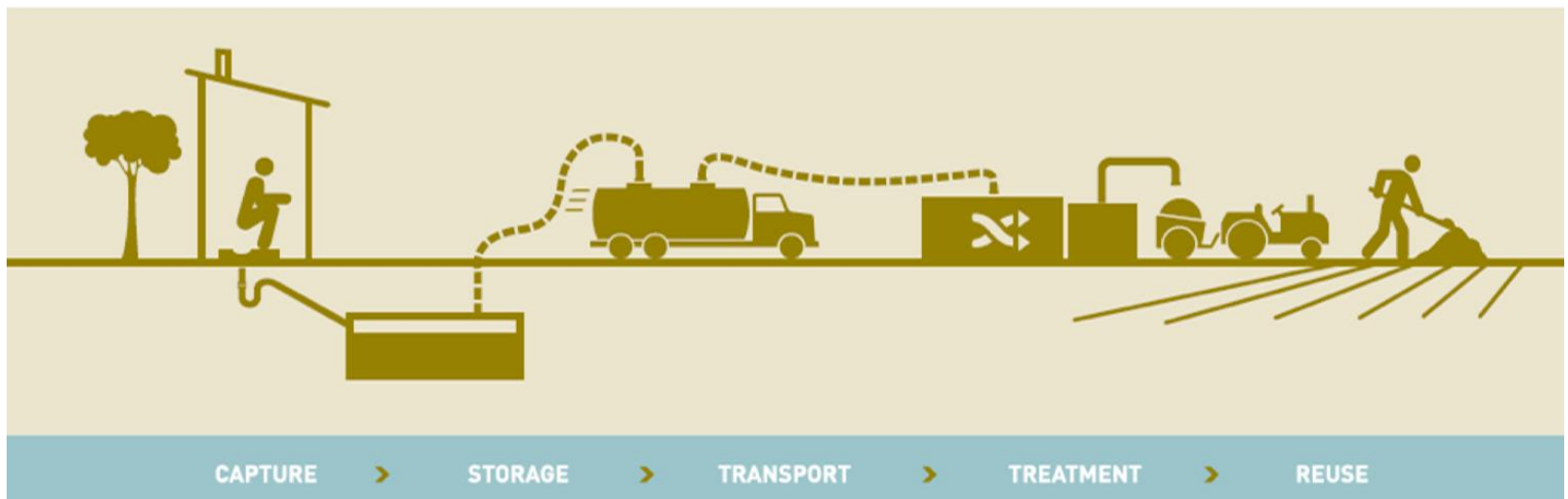


Introduction

- 2.7 billion people worldwide are served through onsite sanitation facilities mostly in developing countries
- However, in most cases they do not safely discharge human waste or treat them properly
- We need for novel, cost-effective, sustainable and efficient technologies for faecal waste management

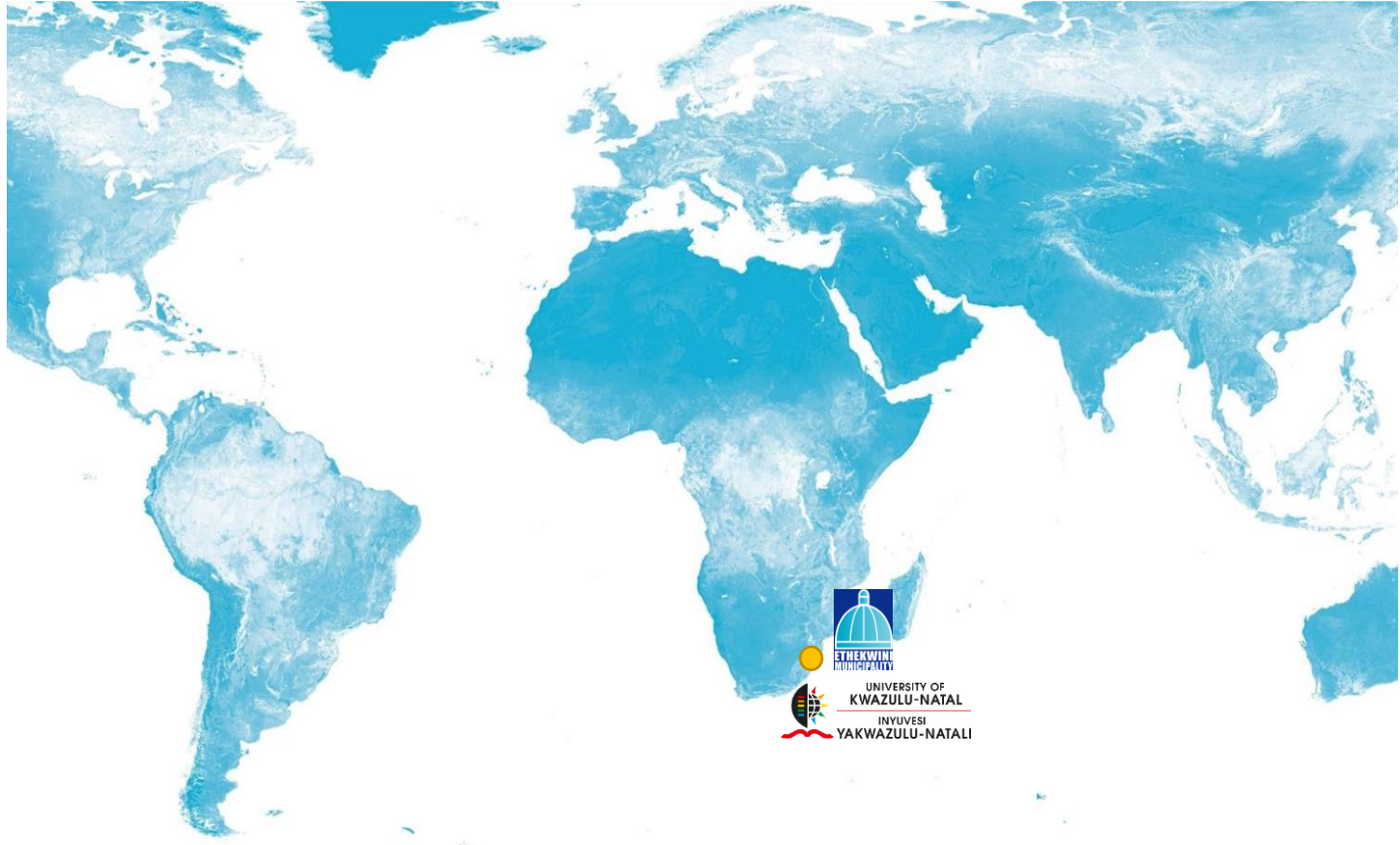


- The entire FSM chain currently requires handling or often direct exposure by the toilet users or the pit emptiers to faecal pathogens.
- Improvement of the entire FSM chain is needed, including collection, transport, treatment and disposal with minimum risks to the public health.



- During the development of innovative technologies for FS treatment, handling FS or faeces presents **health hazard** due to pathogens exposure.
- There is a need of FS simulants during development of innovative sanitation technologies with **no risk of pathogen contamination** and **unpleasant smells**.





Pollution Research Group sanitation laboratory



Materials and methods

- Three initial recipes were selected from other resources and used to mix FS simulants
- The FS simulants were compared to “real” faecal sludge and fresh faeces by some properties, such as:
 - Moisture content,
 - Total, fixed, volatile and suspended solids,
 - Sludge volume index,
 - Chemical oxygen demand,
 - pH,
 - Density,
 - Thermal conductivity,
 - Heat capacity,
 - Calorific value,
 - Rheology and
 - Particle size distribution



- Some recipes were modified in order to match closer to the properties of real faecal sludge.
- Ten different simulants as variations were prepared and analysed in total.
- The comparative properties were selected on the base of the advertised technology prototypes under the Transformative Technologies programme run by the Bill & Melinda Gates Foundation.
- The “real” FS samples were selected from on-site sanitation facilities in the Metro area around Durban, South Africa.
- Standard operational procedures were followed for all the analysed properties and repeated for all samples in order to ensure compatibility.



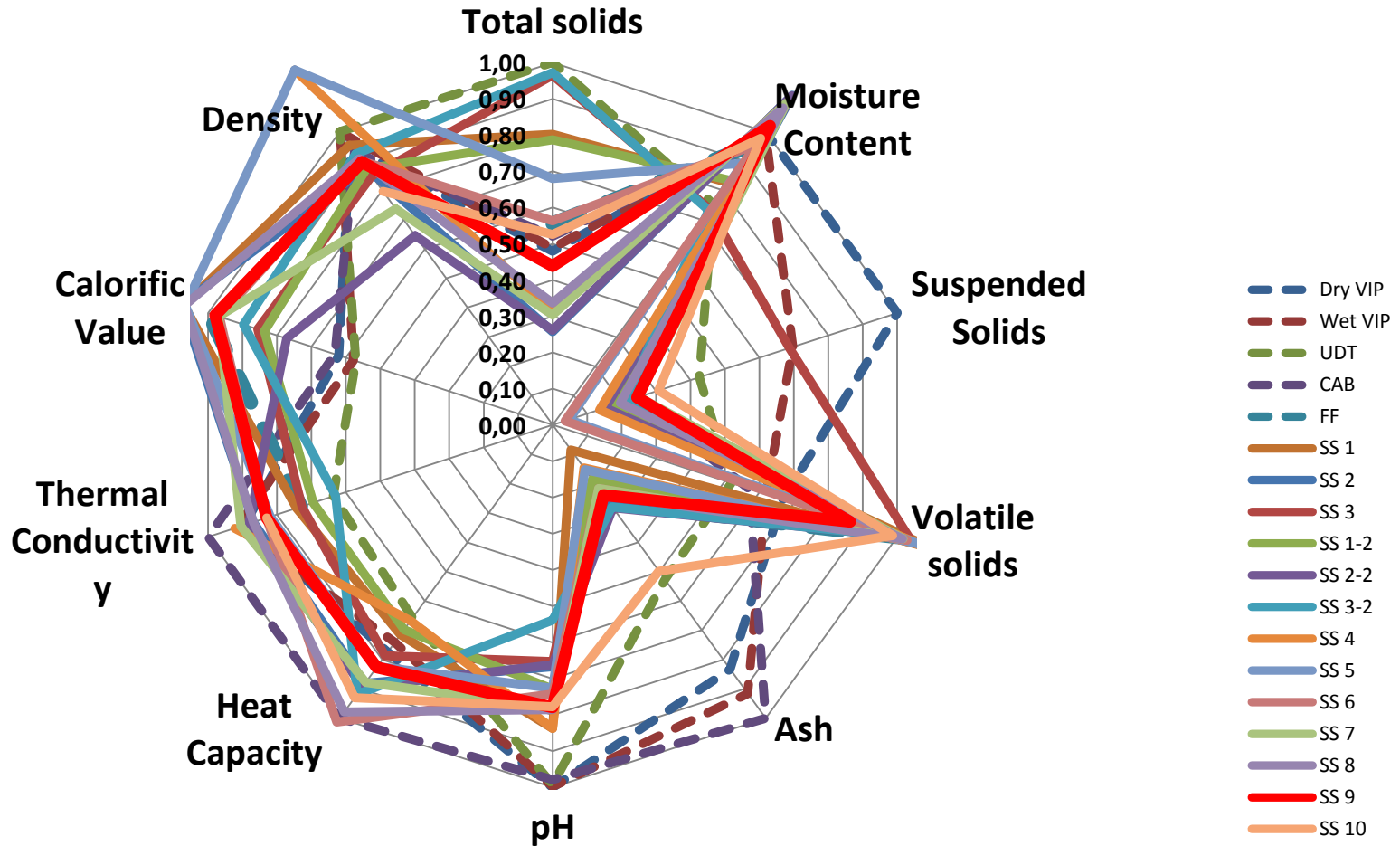
SF simulant



Results - summary

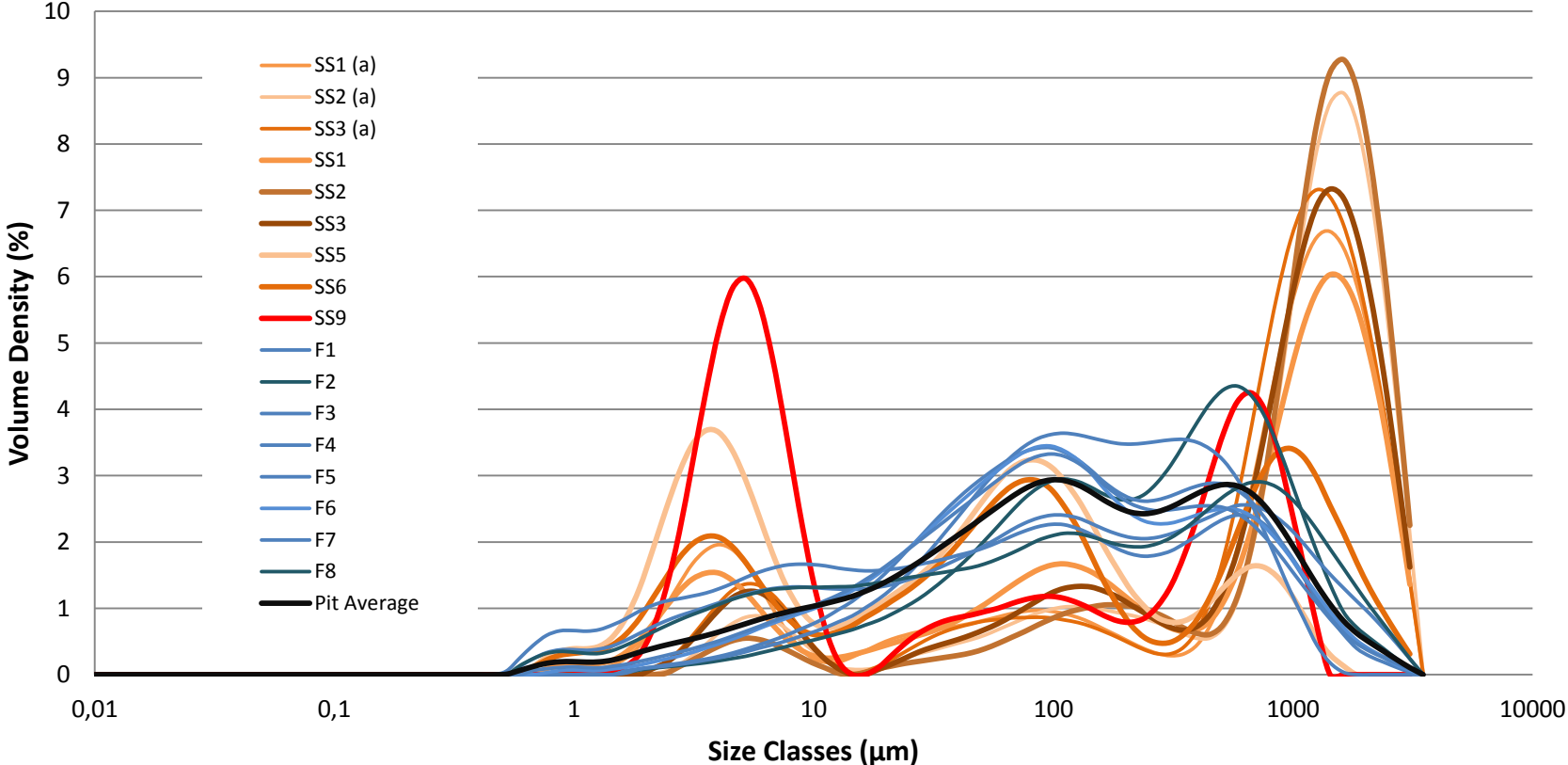
Type of on-site sanitation facility	Total solids	Moisture Content	Suspended Solids	Volatile solids	Ash	Sludge Volume Index	pH	COD	Heat Capacity	Thermal Conductivity	Calorific Value	Density
	%	%	(mg / L)	(g / g dry sample)	(g / g dry sample)	(ml/mg)		(g / g dry sample)	(J/kg/K)	(W/mK)	(MJ/kg)	(kg/m3)
Dry VIP	0.21	0.79	577.57	0.58	0.42	0.04	7.60	0.69	2530.54	0.54	14.06	1379.72
Wet VIP	0.21	0.79	402.36	0.54	0.46	0.06	7.59	0.69	2422.33	0.55	13.08	1447.78
UDT	0.43	0.60	245.86	0.45	0.27	0.23	7.54	0.49	2150.49	0.38	12.93	1450.37
CAB	0.23	0.77	139.03	0.49	0.51	0.51	7.44	0.65	3268.45	0.60	14.31	1350.10
Fresh faeces	0.24	0.76		0.87	0.13			0.66			22.64	
Synthetic sludge 1	0.35	0.65	109.17	0.96	0.04	0.09	6.37	0.97	2337.56	0.45	24.22	1384.00
Synthetic sludge 2	0.11	0.89	121.67	0.87	0.13	0.82	5.08	0.65	2878.07	0.52	24.38	1272.00
Synthetic sludge 3	0.42	0.58	396.67	0.90	0.10	0.01	4.96	0.83	2573.52	0.44	19.37	1232.00
Synthetic sludge 1-2	0.34	0.66	105.00	0.91	0.09	0.19	5.54	2.28	2281.14	0.42	18.94	1268.00
Synthetic sludge 2-2	0.11	0.89	88.33	0.86	0.14	0.91	5.03	0.73	2920.75	0.53	17.48	936.00
Synthetic sludge 3-2	0.42	0.58	121.67	0.86	0.14	0.41	4.10	2.15	3001.07	0.38	20.30	1340.00
Synthetic sludge 4 (increase Moisture of 1-2)	0.14	0.86	78.33	0.93	0.07		6.37		2181.31	0.56		1756.00
Synthetic sludge 5 (Sawdust)	0.29	0.71	27.50	0.92	0.08	4.36	5.52	14.51	2691.26	0.49	24.14	1756.00
Synthetic sludge 6 (Sawdust + tissue)	0.24	0.76	20.70	0.89	0.11	2.42	5.64	2.16	3312.61	0.50	21.89	1308.00
Synthetic sludge 7 (Only cotton linters)	0.13	0.87	144.17	0.88	0.11	1.73	5.95	2.70	2868.97	0.55	21.95	1068.00
Synthetic sludge 8 (cotton linters + tissue)	0.15	0.85	113.33	0.88	0.12	1.32	5.97	1.80	3199.30	0.52	24.18	1316.00
Synthetic sludge 9 (reduced PEG, oil and cellulose)	0.19	0.81	141.67	0.75	0.12	1.76	5.92	1.59	2700.51	0.50	22.17	1300.00
Synthetic sludge 10 (Decrease Moisture)	0.23	0.77	177.50	0.85	0.25	1.52	5.91	1.04	3040.16	0.50	22.17	1156.00

Results Relative comparison

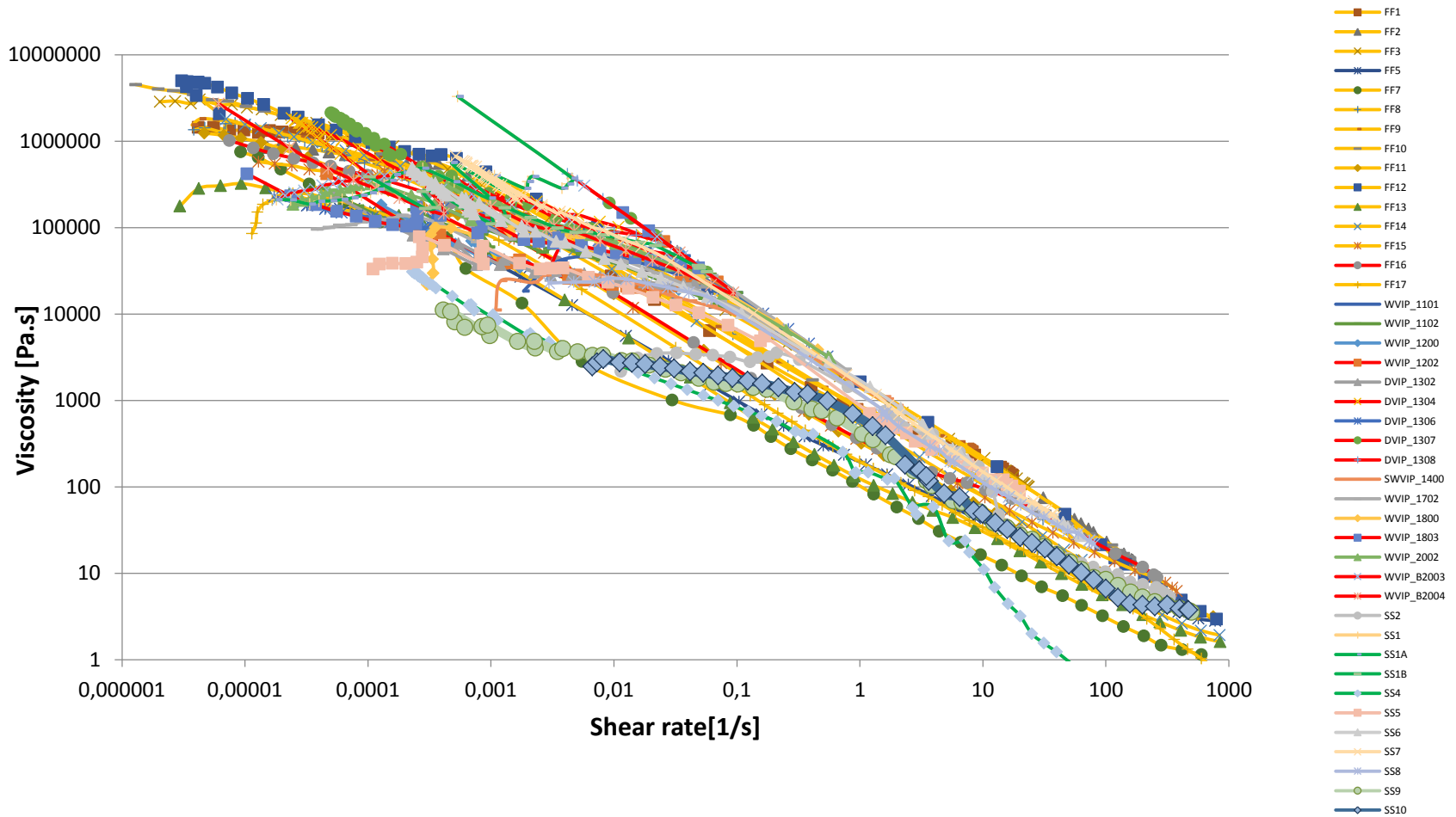


Particle size distribution

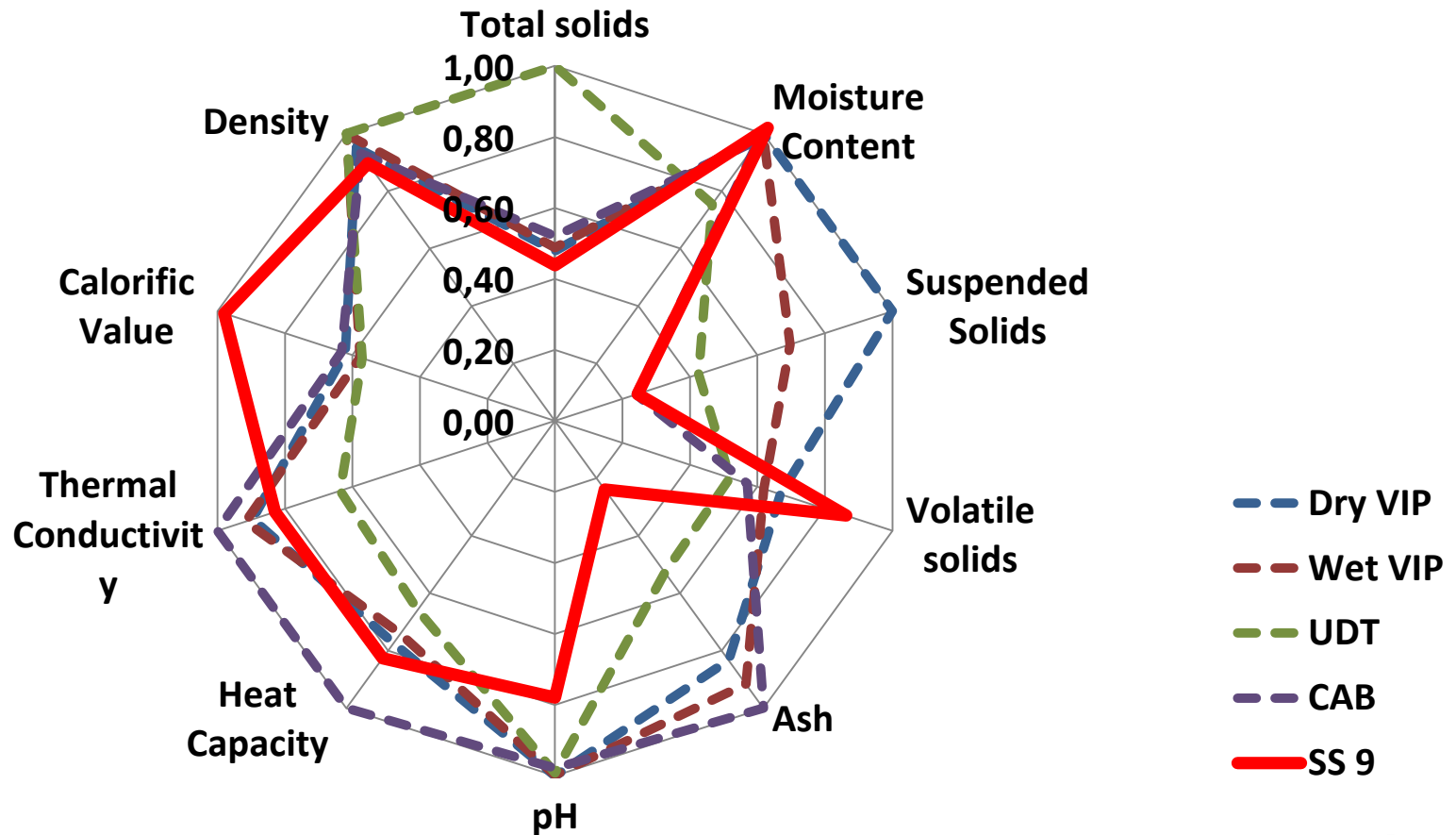
Feecal Sludge (F) versus Synthetic Sludge (SS)



Rheological properties



Comparison between simulants SS9 and SS10 – the closest match to FS



Proposed simulant recipe (SS9)

Recipe 9 FINAL SYNTHETIC SLUDGE RECIPE					
Ingredients	% Wet Mass	Mass for 1 kg	Mass for 500g	Mass for 250g	% Dry Mass
Instant yeast	7.3	72.80	36.40	18.20	32.49
Water	77.6	776.10	388.05	194.03	
Psyllium	2.4	24.30	12.15	6.08	10.84
Peanut oil	3.9	38.80	19.40	9.70	17.31
Miso	2.4	24.30	12.15	6.08	10.84
PEG	2.7	27.20	12.15	6.08	12.14
Inorganic Calcium phosphate	2.4	24.30	12.15	6.08	10.84
Cellulose half cotton lintens/ half tissue -shredded	1.2	12.40	6.20	3.10	5.53
Total Mass	100.0	1000.20	500.10	250.05	100.00



Toilet fair India 2014 – application of FS simulant (SS9)

The Recipe for Fake Poop



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Researchers around the world are working to [reinvent the toilet](#), bringing toilets to the 2.5 billion people worldwide who don't have a safe place to relieve themselves. But there's a slightly gross problem—how do you test a toilet in a sanitary and, ahem, *repeatable* way?

Enter "fake poop," my preferred term for what scientists call "synthetic sludge simulant." Yes, this is a material meant to simulate fecal matter, and it has to have properties very similar to real fecal matter—minus all the pathogens, odors, and grossness. For this year's [Reinvent the Toilet Fair](#), a new recipe was developed by the [Pollution Research Group](#) at the [University of KwaZulu-Natal](#), South Africa. Their recipe was inspired by a research paper on simulated fecal

<http://mentalfloss.com/article/56003/recipe-fake-poop>





Thank you!

Velkushanova@ukzn.ac.za

