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Letter to the Editor

Dear Editor,

I have just come across the paper "Simulation of vapor emissions from liquid spills", by T.A. Cavanaugh II, J.H. Siegell and K.W. Steinberg, J. Hazard. Mater., 38 (1994) 41–63.

Their model of spreading pools derives from that presented in an AEA report by Shaw and Briscoe (1978). In the Shaw and Briscoe model the radius of the pool goes like the square root of time (with perhaps a small modification due to vaporisation). The spreading velocity therefore goes like $1/\sqrt{t}$ and the kinetic energy associated with spreading therefore falls as $1/t$ (or more rapidly if the pool is vaporising).

The statement of Cavanaugh et al., following their Eq. (11), that this represents potential energy being converted into kinetic, is clearly incorrect – the pool is rapidly losing kinetic energy.

I am drawing this to your attention as it is in fact a very popular misconception, which needs to be eradicated. The Shaw and Briscoe model was an early attempt at a pool spread and vaporisation model, which broke new ground and had much to commend it. However it also had some shortcomings, not least the pool spread model.

At AEA we have recognised these and done a significant amount of work to overcome them. This work includes a consistent understanding of radial pool spread, and is presented in numerous publications [1–6].

If vaporisation, viscosity, and resistance forces are neglected, the kinetic energy will increase to an asymptotically constant value equal to the initial potential energy, with radius increasing linearly with time. However, this is a very poor representation of a real pool. In reality the spread rate depends crucially upon resistance effects implying turbulent energy dissipation and, as the pool becomes very thin, laminar viscous effects.

The references below present an idealisation based on sound physics considerations. They do not by any means give a complete solutions of the problem of spreading on real surfaces, but may inspire others to make further improvements.

[1] D.M. Webber and S.J. Jones, in J. Woodward (Ed.), Proc. Int. Conf. Vapor Cloud Modeling, AlChE, New York, 1987, pp. 226–250.

[2] D.M. Webber and P.W.M. Brighton, J. Fluids Eng., 108 (1986) 238.

[3] D.M. Webber, J. Loss Prev. Proc. Ind., 4 (1991) 5.

[4] D.M. Webber and P.W.M. Brighton, in S. Hartwig (Ed.), Heavy Gas and Risk Assessment III, Reidel, Dordrecht, 1986, p. 223.

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[5] D.M. Webber and P.W.M. Brighton, Similarity Solutions for the Spreading of Liquid Pools, UKAEA Report SRD R 371, 1986.
[6] D.M. Webber and P.W.M. Brighton, An Integral Model for Spreading, Vaporising Pools derived from shallow-layer Equations, UKAEA Report SRD R 390, 1987.

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Dear Editor,

We appreciate the comments provided by Dr. Webber in that they identify an alternative methodology for estimating pool spread that was not available at the time we developed the Liquid Spills Model (LSM). As we indicated in our paper [1], the pool spread model presented by Shaw and Briscoe [2] ignores viscosity and surface tension effects and, therefore, may not be valid for highly viscous materials. Most spills that are of concern because of rapid evaporation, however, are of lower viscosity and thus the Shaw and Briscoe model approximation is likely to be an adequate representation for pool spread.

As part of our validation of LSM, we compared the predicted pool radius to the reported values from the Burro field tests [3]. As shown in Table 1, predictions from LSM for equilibrium pool radius were found to be within 18% of Burro observations with an average difference of just 11.7%. (The equilibrium pool radius from the Burro tests was estimated using the pool area and time at the point designated as "equilibrium boil-off".)

Comparisons of predicted to measure pool spread for the mode referenced by Dr. Webber [4] appear to indicate similar aggrement to that achieved by LSM, with a maximum variation of about 13%. Exact comparison is difficult, however, since Dr. Webber's papers include graphical rather than tabular comparisons.

Thus, we believe that while there may now be alternative and perhaps more sophisticated models for pool spread than were available when LSM was developed, the approach used in LSM appears to be adequate in simulating petroleum liquid spills of the type which may be a concern due to evaporation and cloud formation.

Table 1

Expt.	t (s)	Observed	LSM Prediction	% Error
Burro-4	33	12.3	13	5.4
Burro-5	32	12	13.9	15.4
Burro-7	35	13.5	14.8	9.8
Burro-8	36	14.1	15.6	10.7
Burro-9	38	15.1	17.2	17.4
			Avg. Percent Error	11.7