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The Study of Cooling Water Discharge into British Waterways Canal

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Aim
To develop a 3D interactive mathematical model to ensure safe and effective use of a natural resource.

Advantages of British Waterways canal water cooling system
• Using British Waterways canals for cooling systems can save £100 million on energy bills
• Reduce carbon emissions by one million tonnes.

The problem
Excessive increase in ambient water temperature reduces the dissolved oxygen in the water which threatens aquatic life.

2200 miles of canals and rivers across the UK available for use

Results
The final predictive model has been applied to existing canal sites where the results compare very favourably with the measured on-site results. It is now complete for national use on canal waters and lakes.

Conclusion
The work results in an interactive model that can be used to maximise use of canal water and lakes without prejudice to aquatic life. Environmental Agency approval is now being sought for its use on a national scale.

Discharge plume
Discharge heated water
Discharge thermal plume

What size is the plume?

On-site measurements
Laboratory Testing

Central Services Building University of Huddersfield

Cooling water discharge into British Waterways canal

Graduated pole carried the measurements tools at canal site

Thermal camera used to predict the heat distribution on the surface

Plan view of thermal plume resulted from the mathematical model
Sectional view of thermal plume resulted from the mathematical model

Coloured water discharged into tank

Experimental model tank setup

Coloured water shows the vertical extension of the plume

Theoretical centreline temperature decay of thermal plume and comparison with canal measured data (Lockside)

\[ T(x, y) = \frac{To - Ta}{2} \left( \text{erf} \left( \frac{b - z}{2\sqrt{p \cdot x}} \right) + \text{erf} \left( \frac{b + z}{2\sqrt{p \cdot x}} \right) \right) + Ta \]

To, Ta: Discharge and Ambient Temperature, b: Nozzle Radius, z: Depth, p: Velocity/Diffusivity

Theoretical centreline velocity of thermal plume and comparison with canal measured data (Lockside)