Propeller Characteristics in Oblique Flow
Case 1

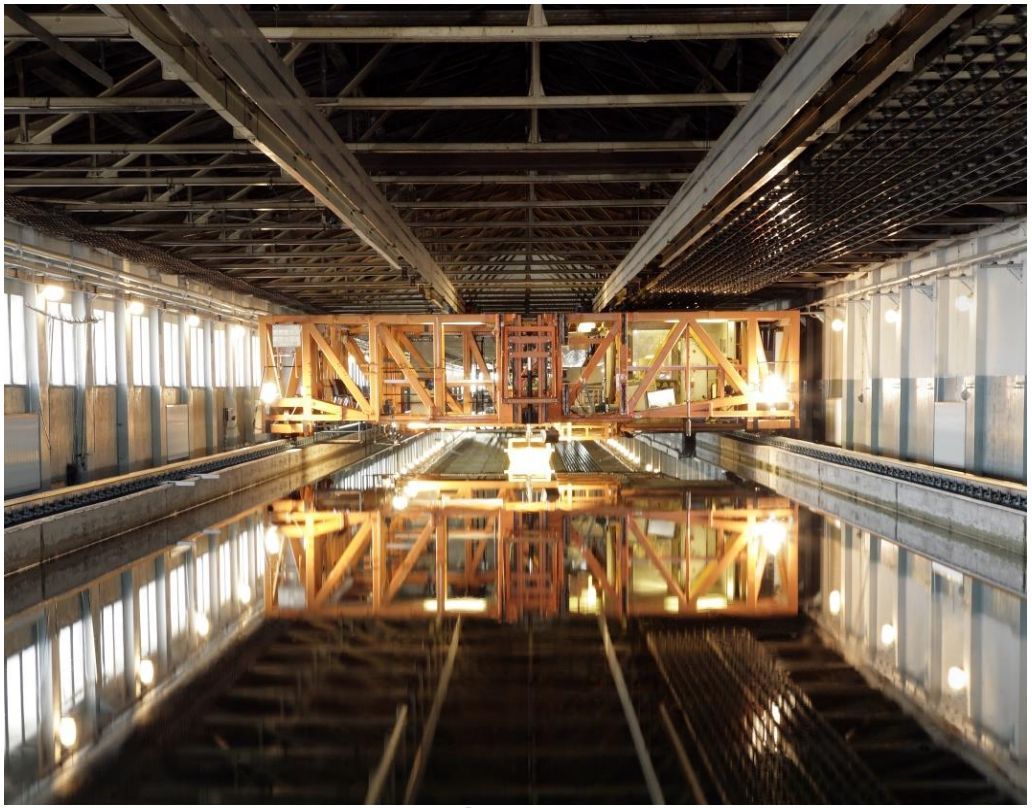
Ulf Barkmann

Potsdam Model Basin (SVA)

The Fourth International Symposium on Marine Propulsors 2015 – smp‘15

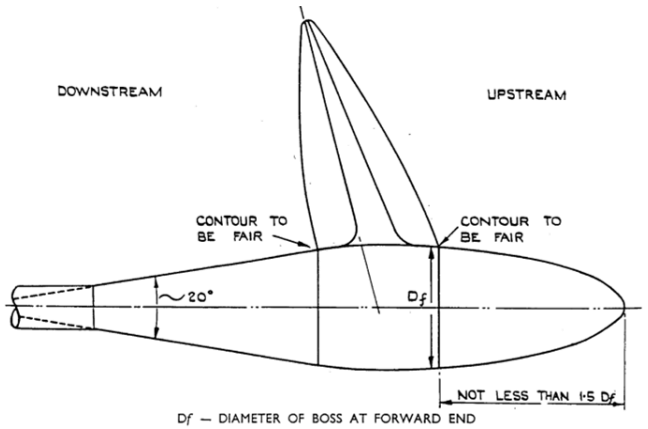
Open water test

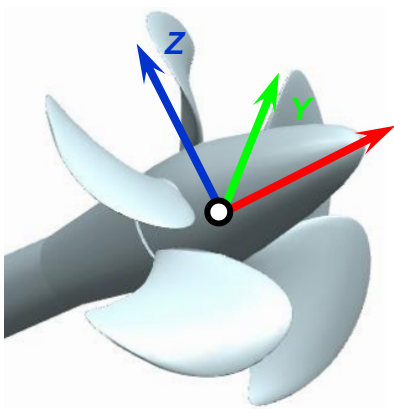
- Tests were conducted in the towing tank of the SVA
- Dynamometer mounted behind the propeller with an inclination of 12°



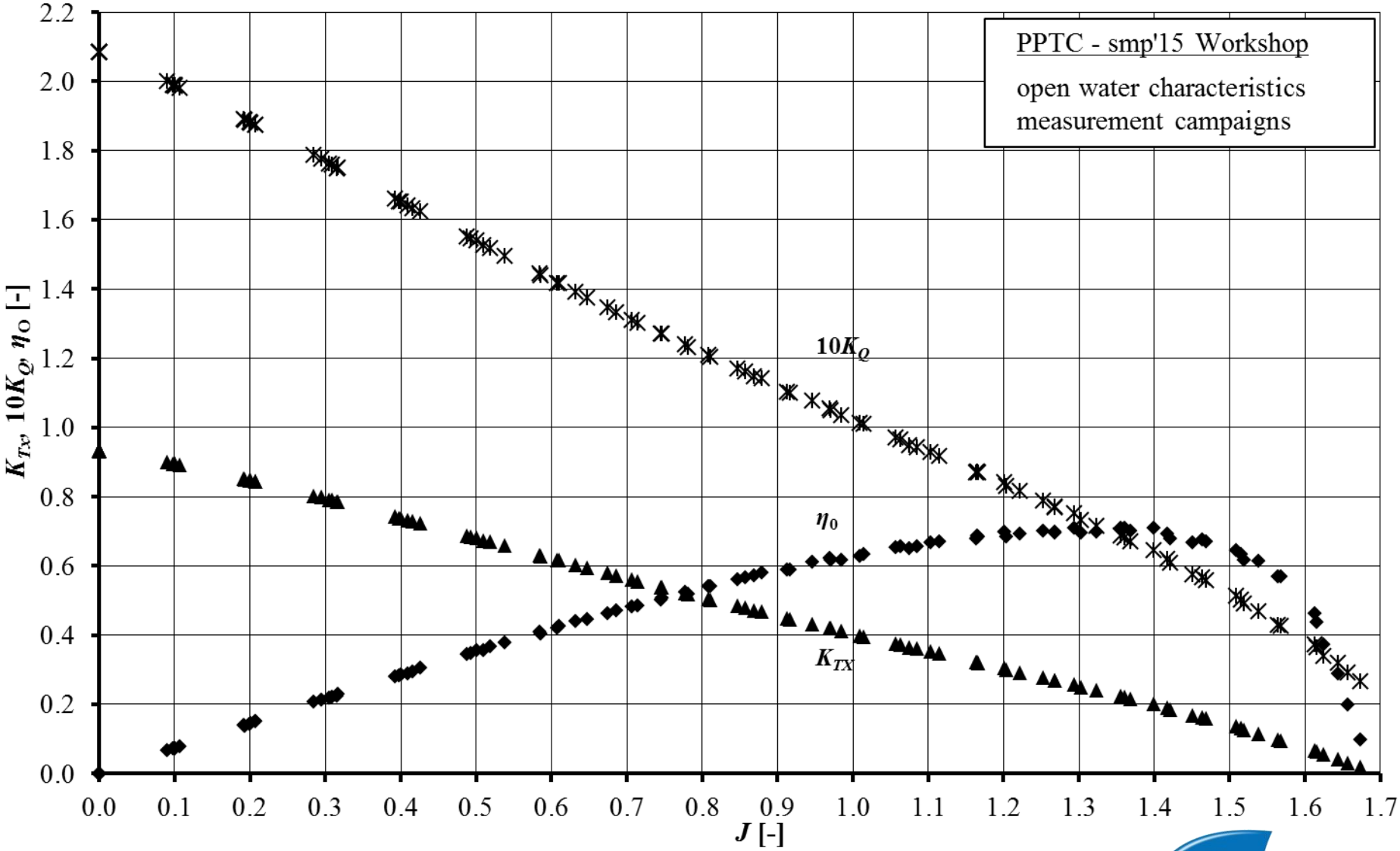
Open water test

- The open water tests were carried out according to the ITTC recommended procedure 7.5-02-03-02.1 (2008) :
  - Streamlined cap longer then 1.5 D_f
  - Cone with 20° opening angle
  - Immersion of the propeller center: 1.5 D
  - Prior tests with cap and hub without blades
  - Hub of the same weight and shape as the propeller hub with blades

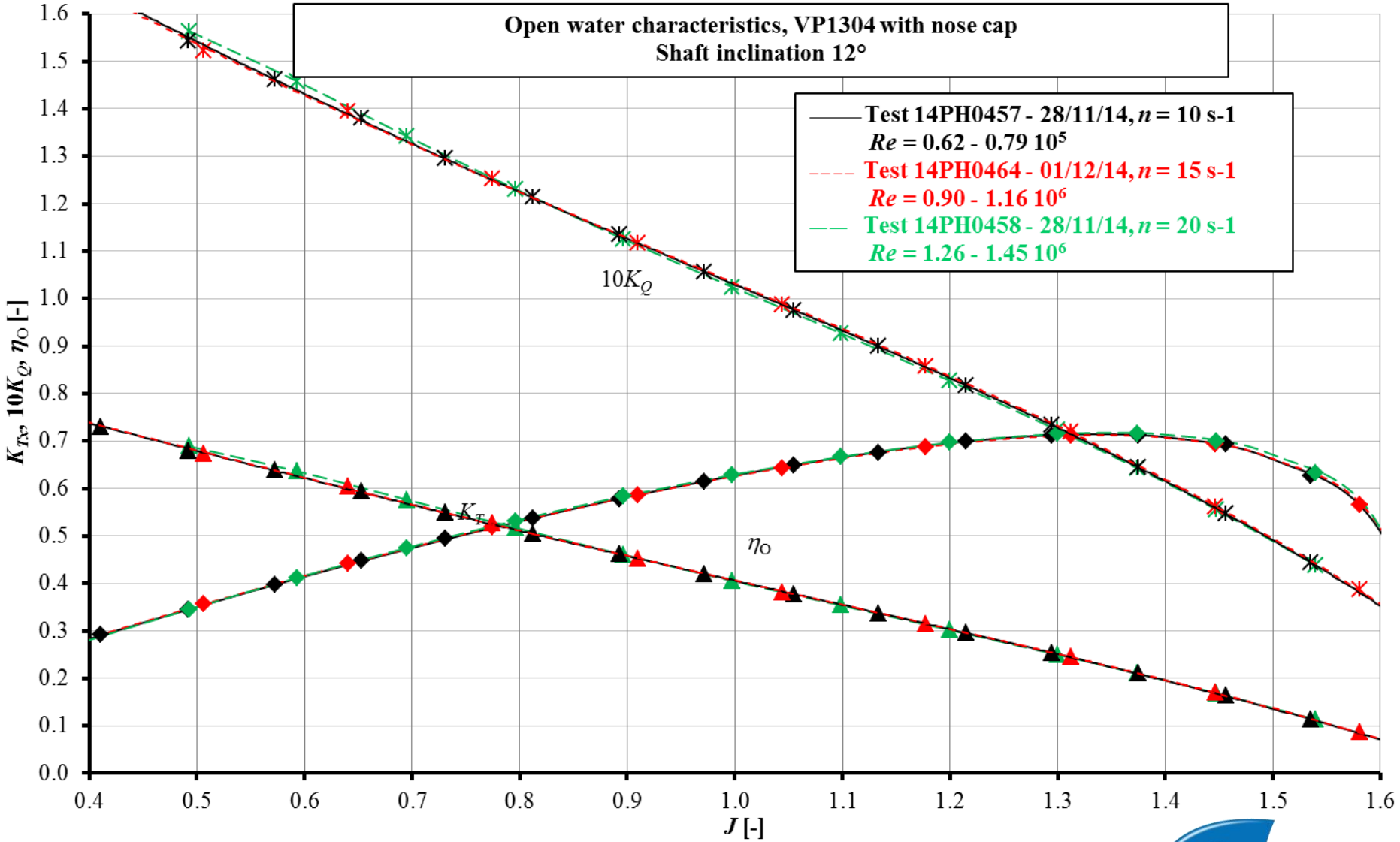




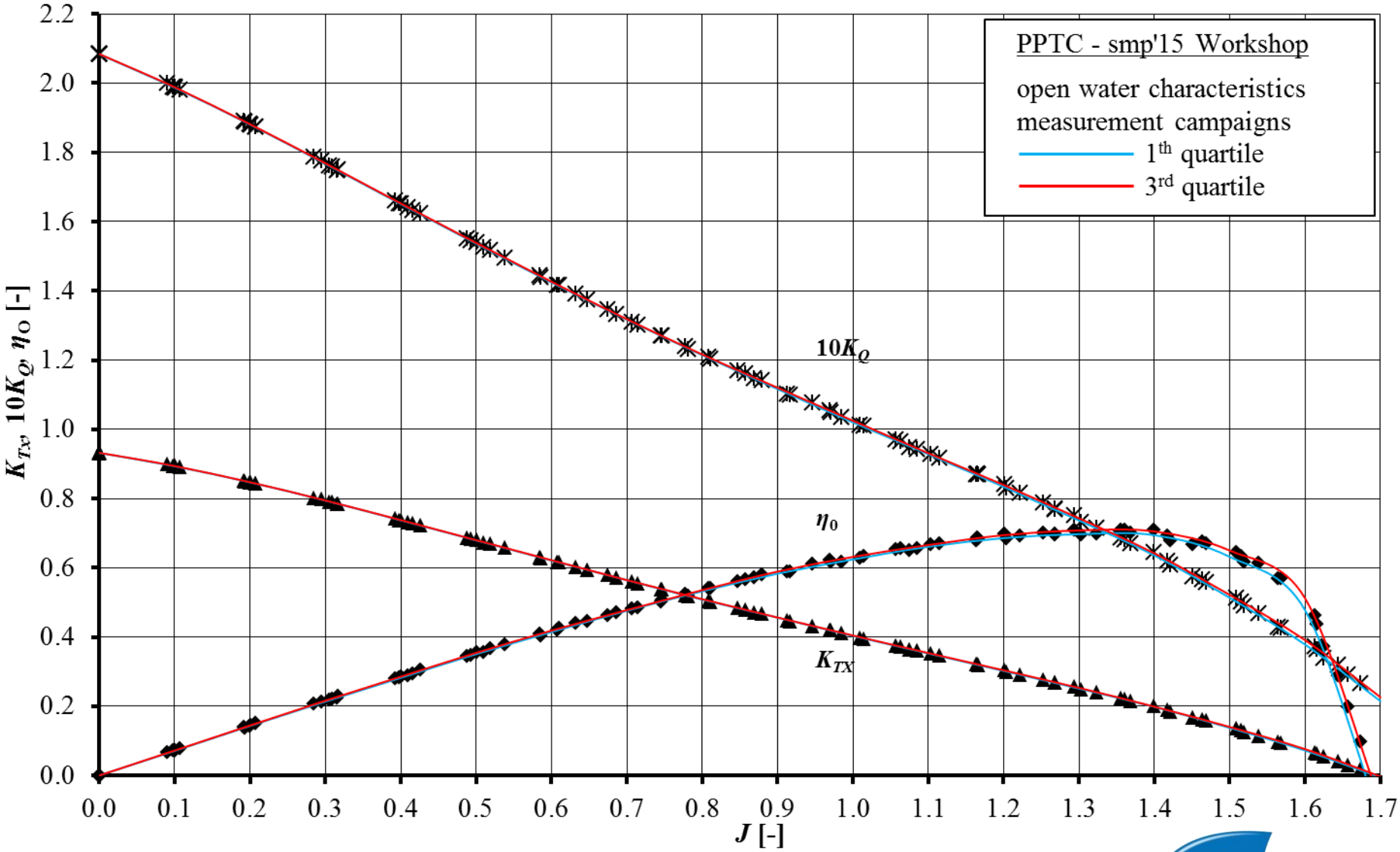
Open water characteristics - EFD



Reynolds number effects - EFD



Error estimation - EFD

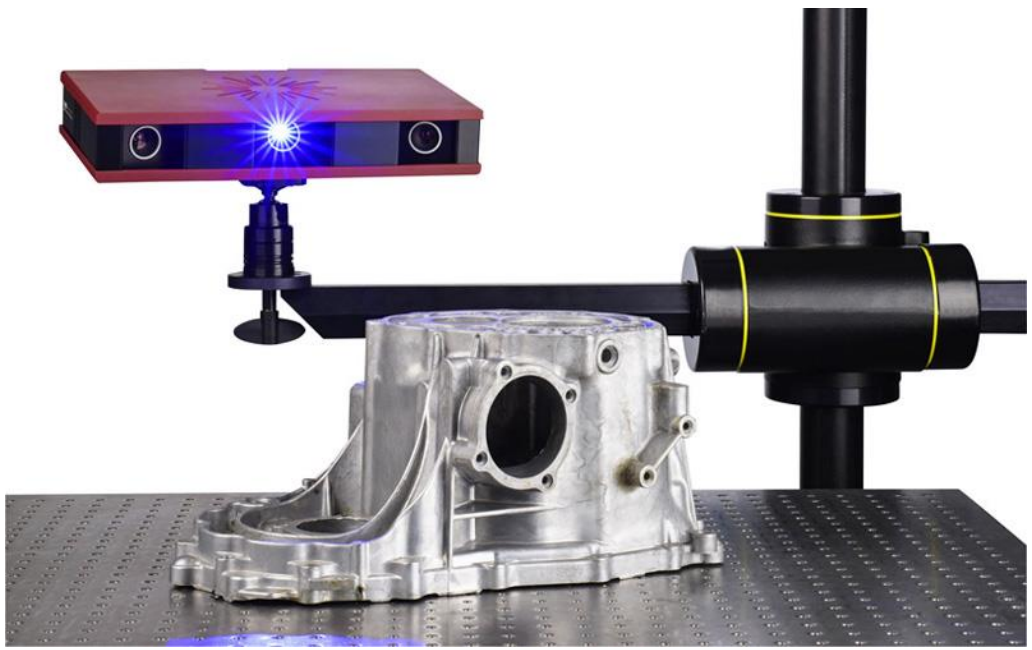


Propeller accuracy

Ongoing R&D project **„Quality“**

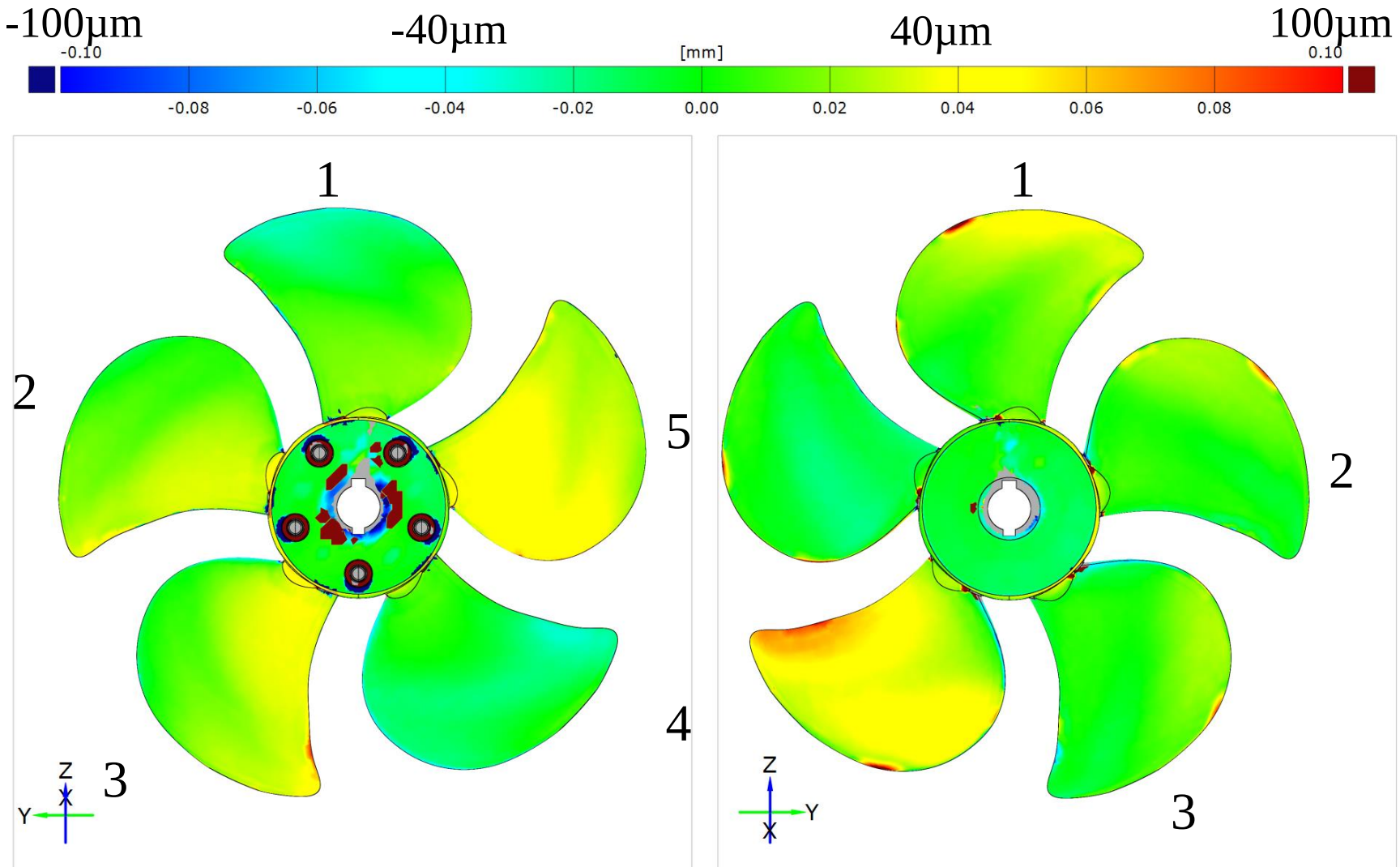
Bundesministerium
für Wirtschaft
und Technologie

The influence of the production quality on the open water characteristics shall be investigated



- Surface of propellers are measured with a photogrammetric system
- Grids with 300.000 measurement points were compared to CAD
- Accuracy of 0.03 mm

Propeller accuracy

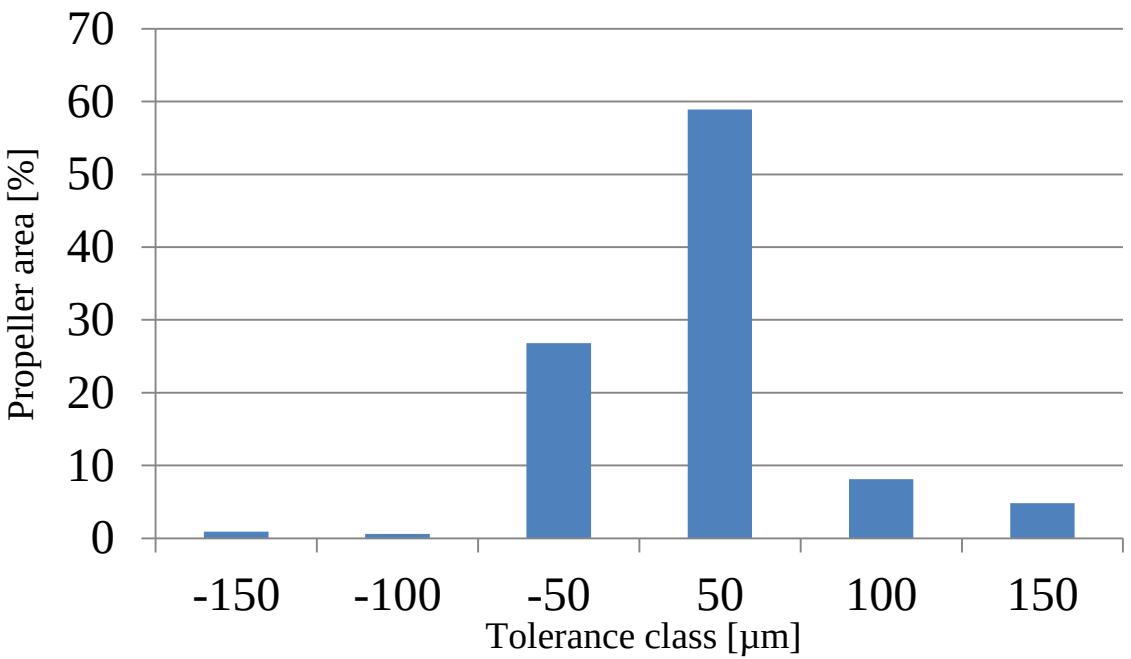


Pressure side

Suction side

Propeller accuracy

Tolerance class	Percentage of area [%]
150 µm	4.8
100 µm	8.1
50 µm	58.9
-50 µm	26.8
-100 µm	0.6
-150 µm	0.9

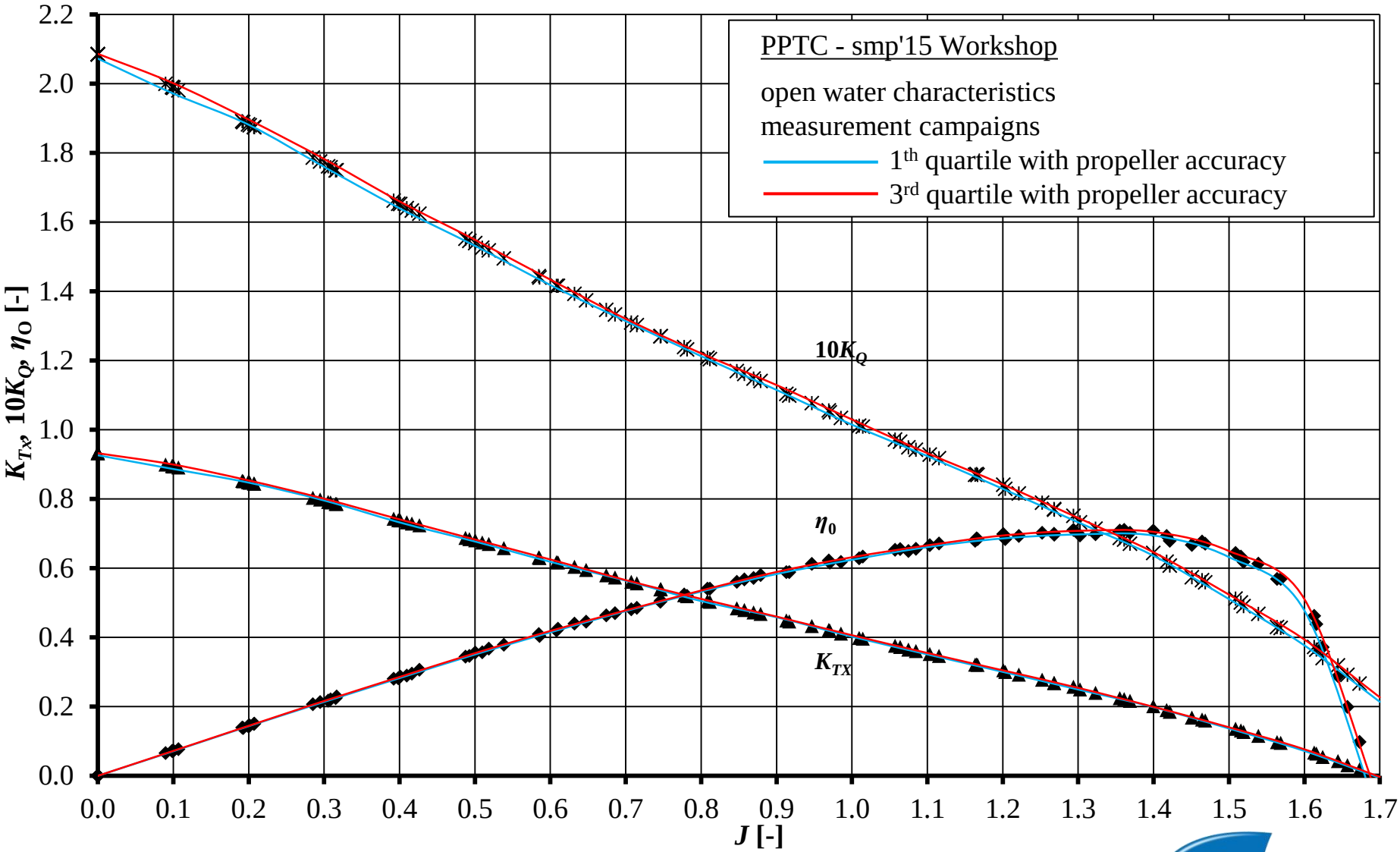


Median: 29.4 µm

Propeller corresponds very well to the ITTC procedure 7.5-01-02-01 (2008)

Worst case estimation: 100 µm ➔ **1% K_T, 10K_Q**

Error estimation II - EFD

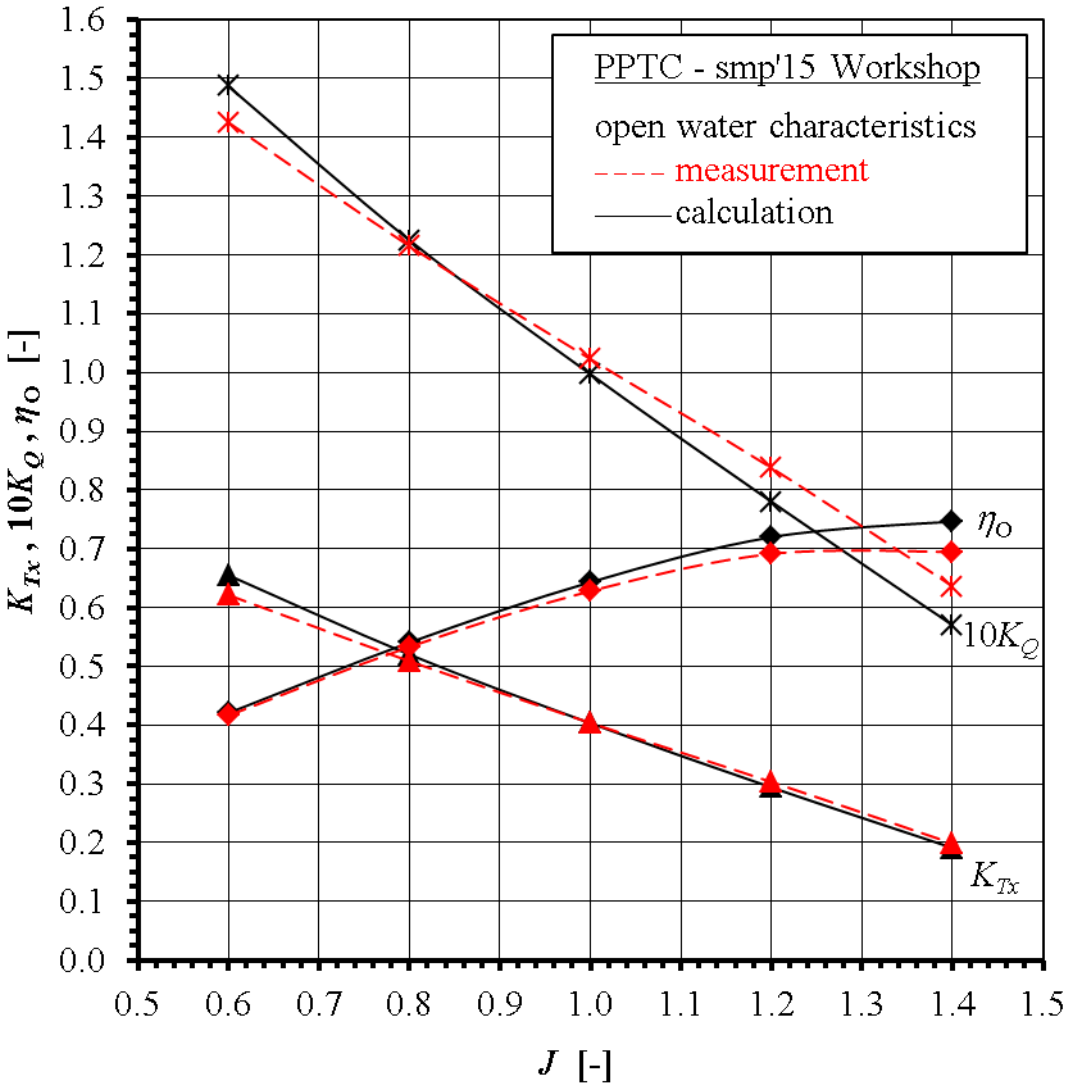


Participants

11 groups, 11 solvers, 16 calculations

Group	Solver	Acronym
ACCUSIM	ANSYS-CFX	ACCUSIM-CFX
	OpenFOAM	ACCUSIM-OF
CNRS-ECN	ISIS	CNRS-ISIS
CRADLE	SCTetra steady	CRADLE-SCTetra-st.
	SCTetra unsteady	CRADLE-SCTetra-unst.
CSSRC	ANSYS-Fluent	CSSRC-Fluent
ROTAM	ANSYS-Fluent	ROTAM-Fluent
MARIN	ReFresco	MARIN-ReFresco
TU Hamburg Harburg	ANSYS-CFX	TUHH-CFX
	OpenFOAM	TUHH-OF
	panMARE	TUHH-panMARE
University of Duisburg, Essen	ISIS	UDE-ISIS
University of Genoa	BEM	UniGenoa-BEM
	StarCCM+	UniGenoa-StarCCM
University of Austin	PROPCAV	UTAustin-PROPCAV
VTT	FinFlo	VTT-FinFlo

ACCUSIM CFX


PPTC - smp'15 Workshop
open water characteristics
measurement
calculation
η_O
$10K_Q$
K_{Tx}
K_{Tx}, $10K_Q$, η_O [-]
J [-]
1.6
1.5
1.4
1.3
1.2
1.1
1.0
0.9
0.8
0.7
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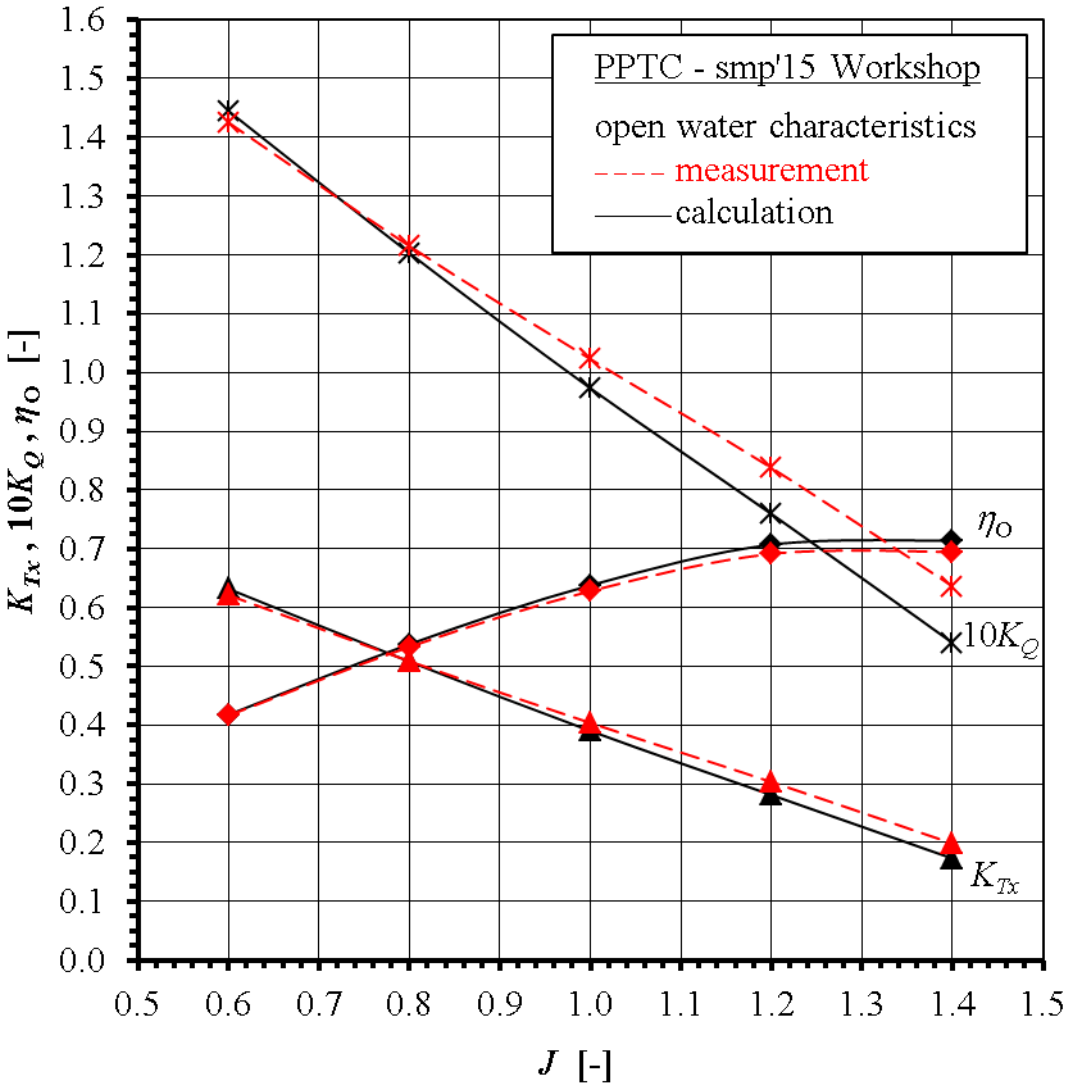
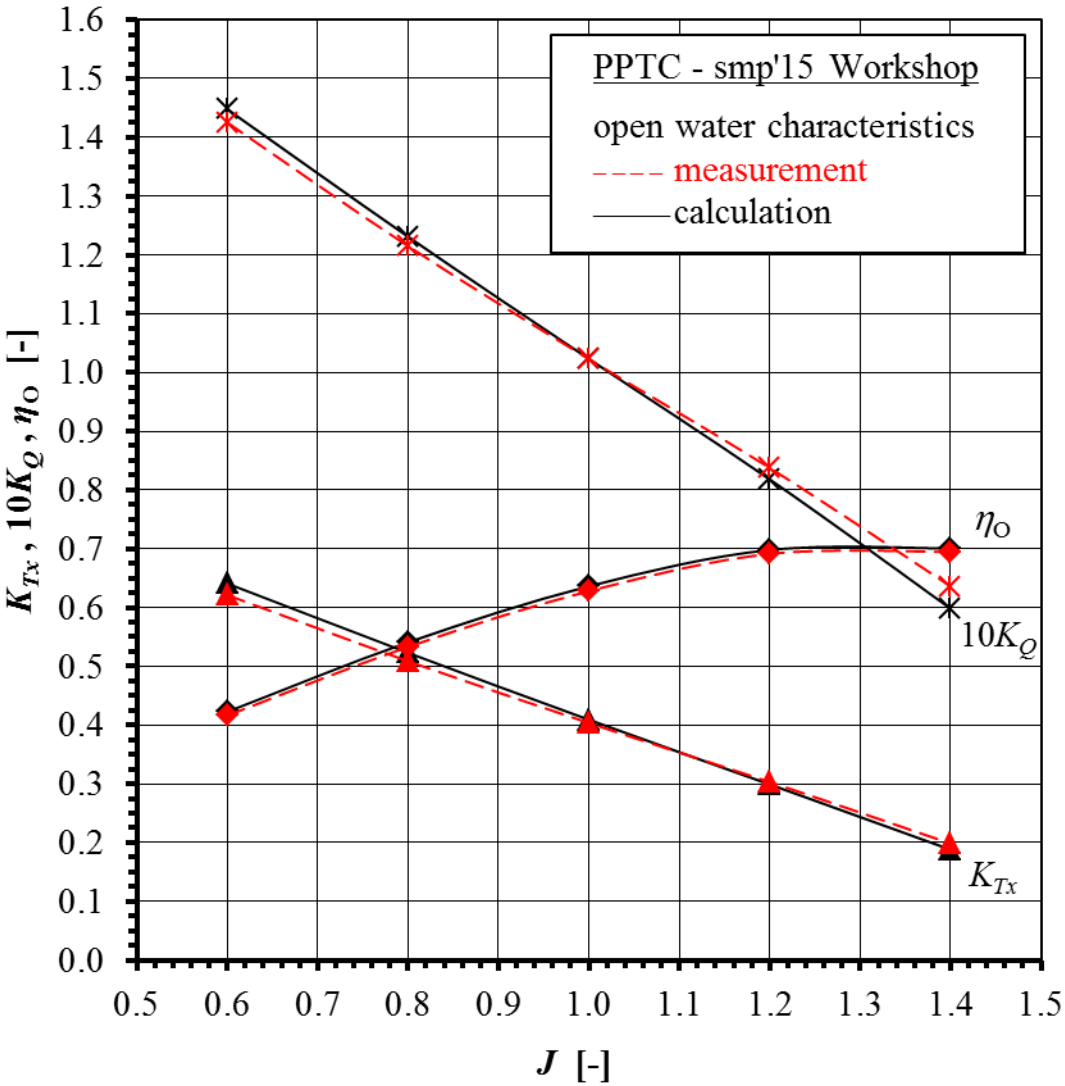
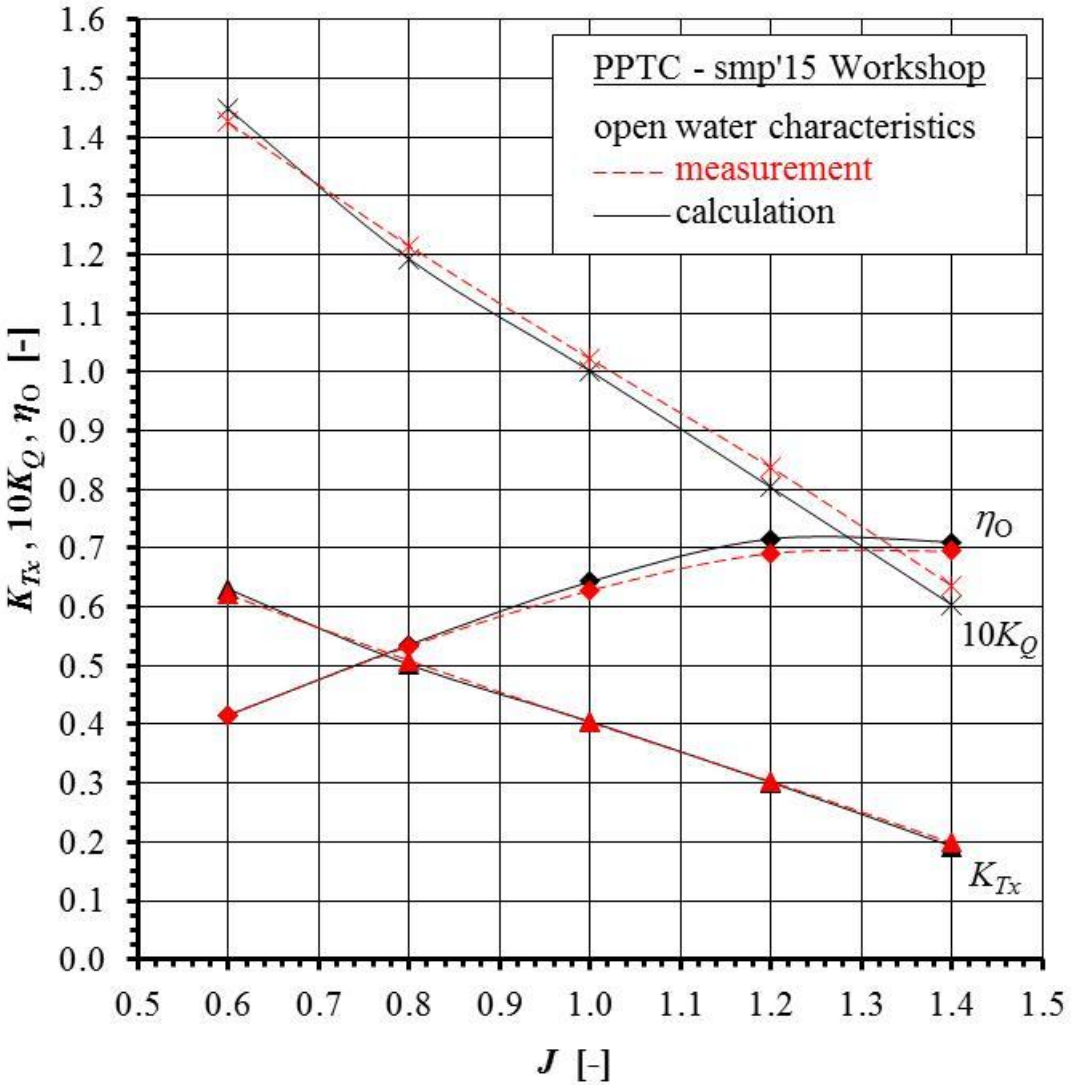
ACCUSIM OpenFoam



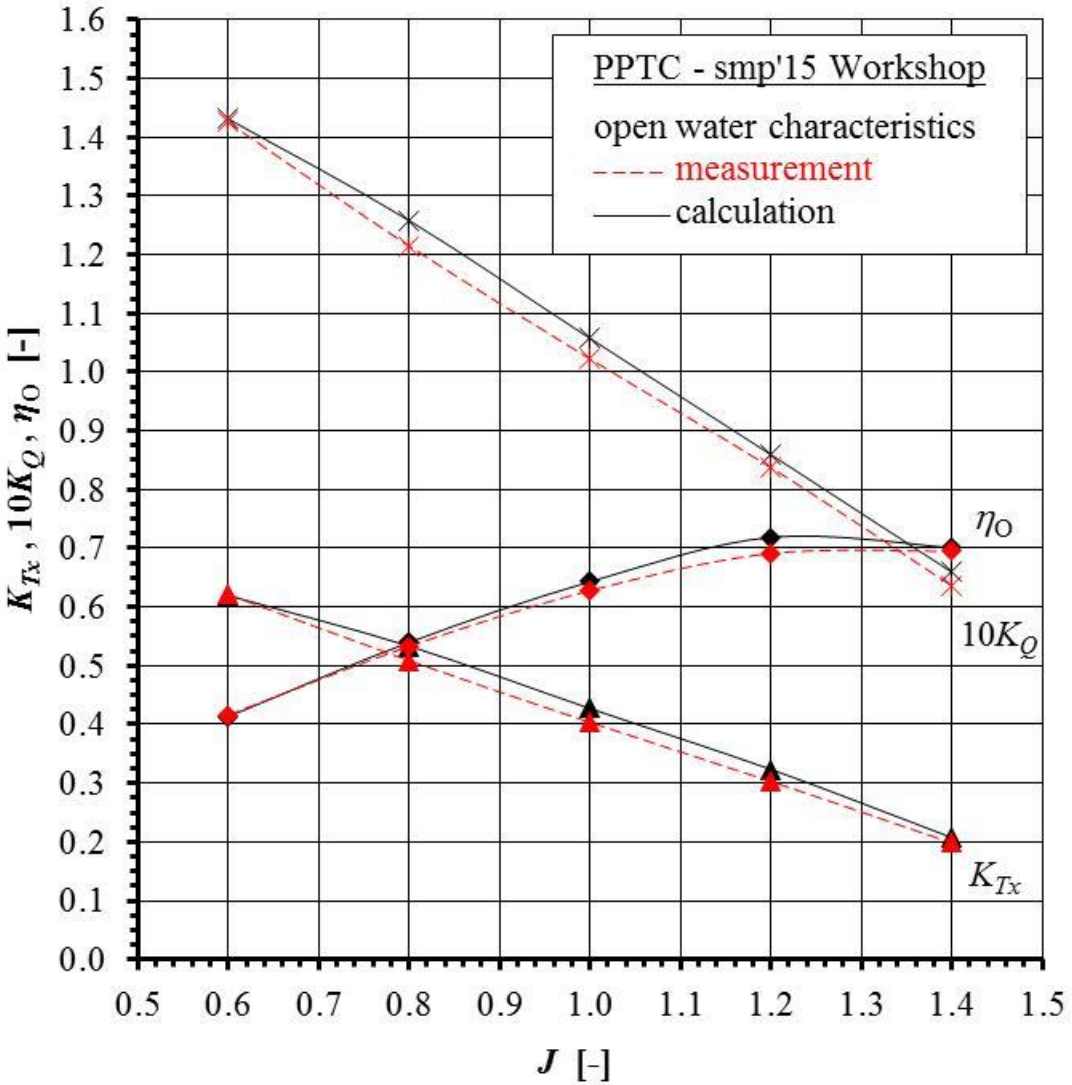
CNRS ISIS (update)



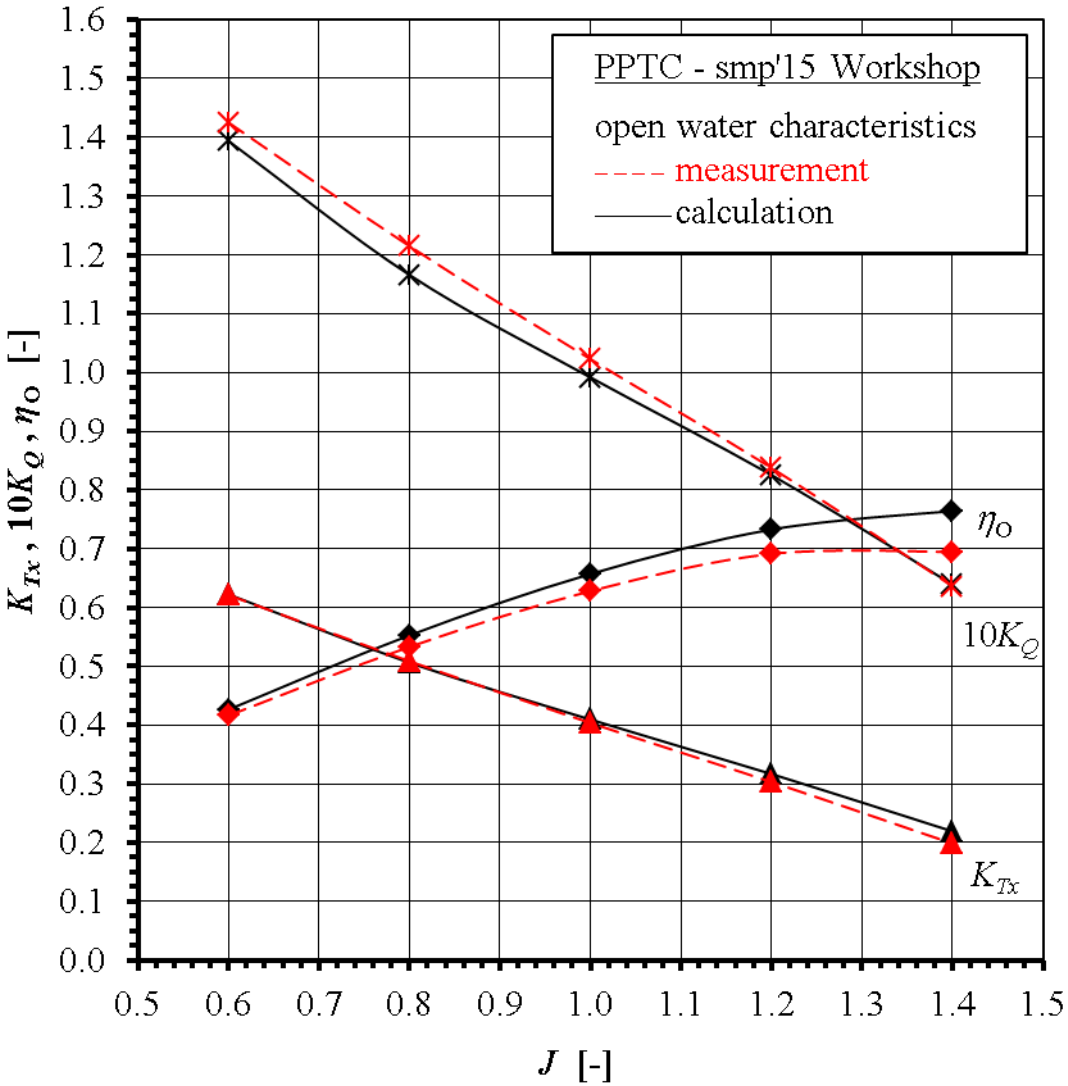
CRADLE SCTetra (steady)



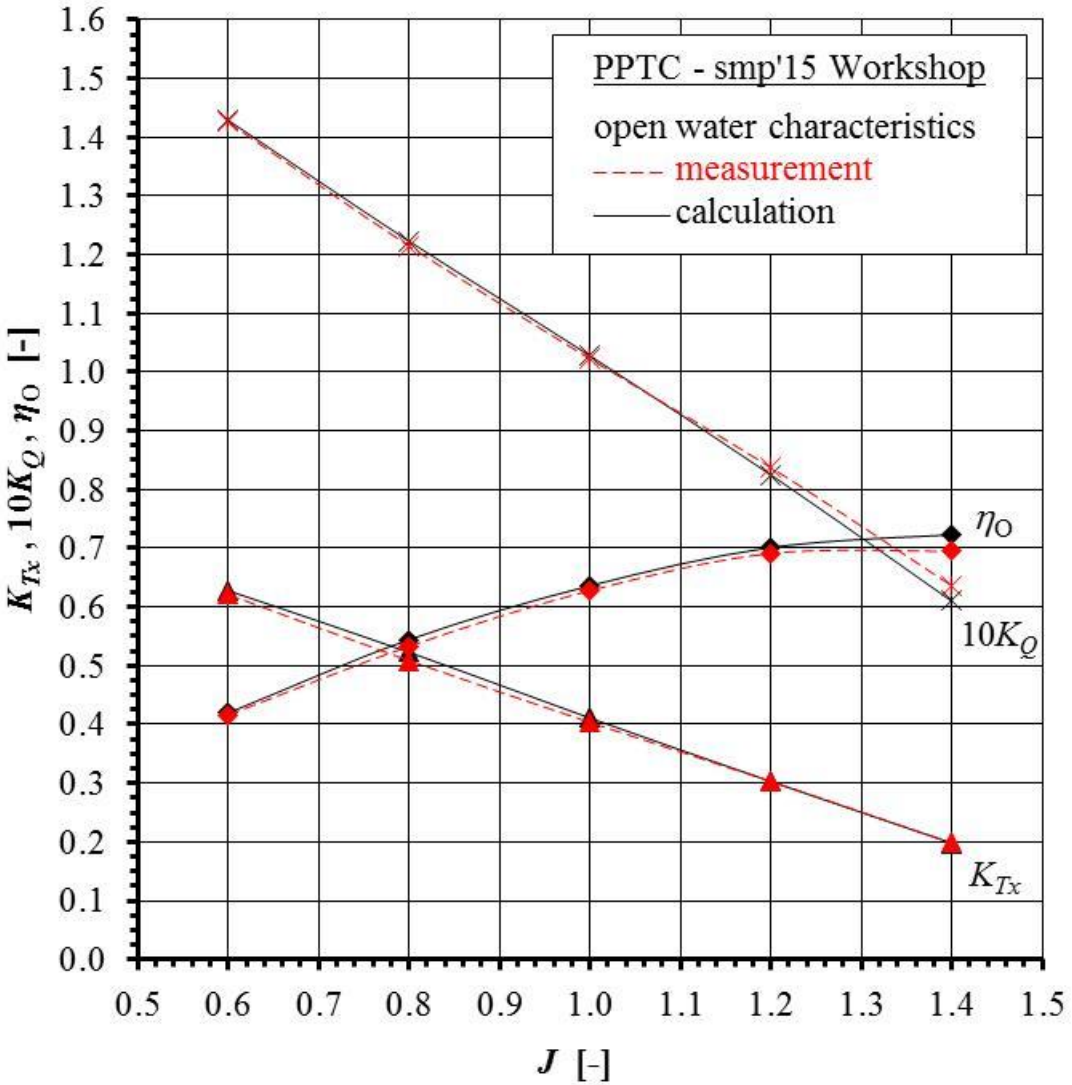
CRADLE SCTetra (unsteady)



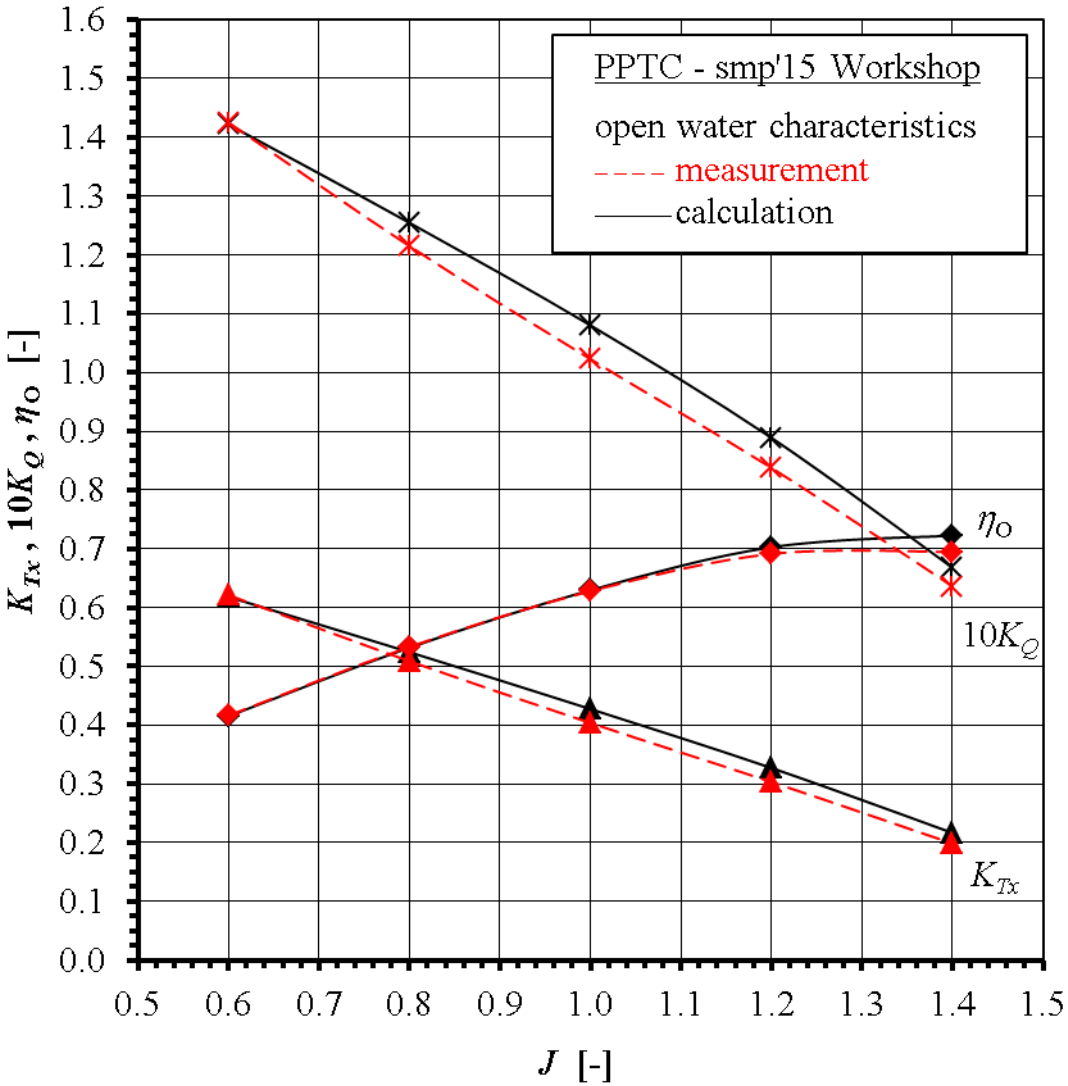
CSSRC Fluent

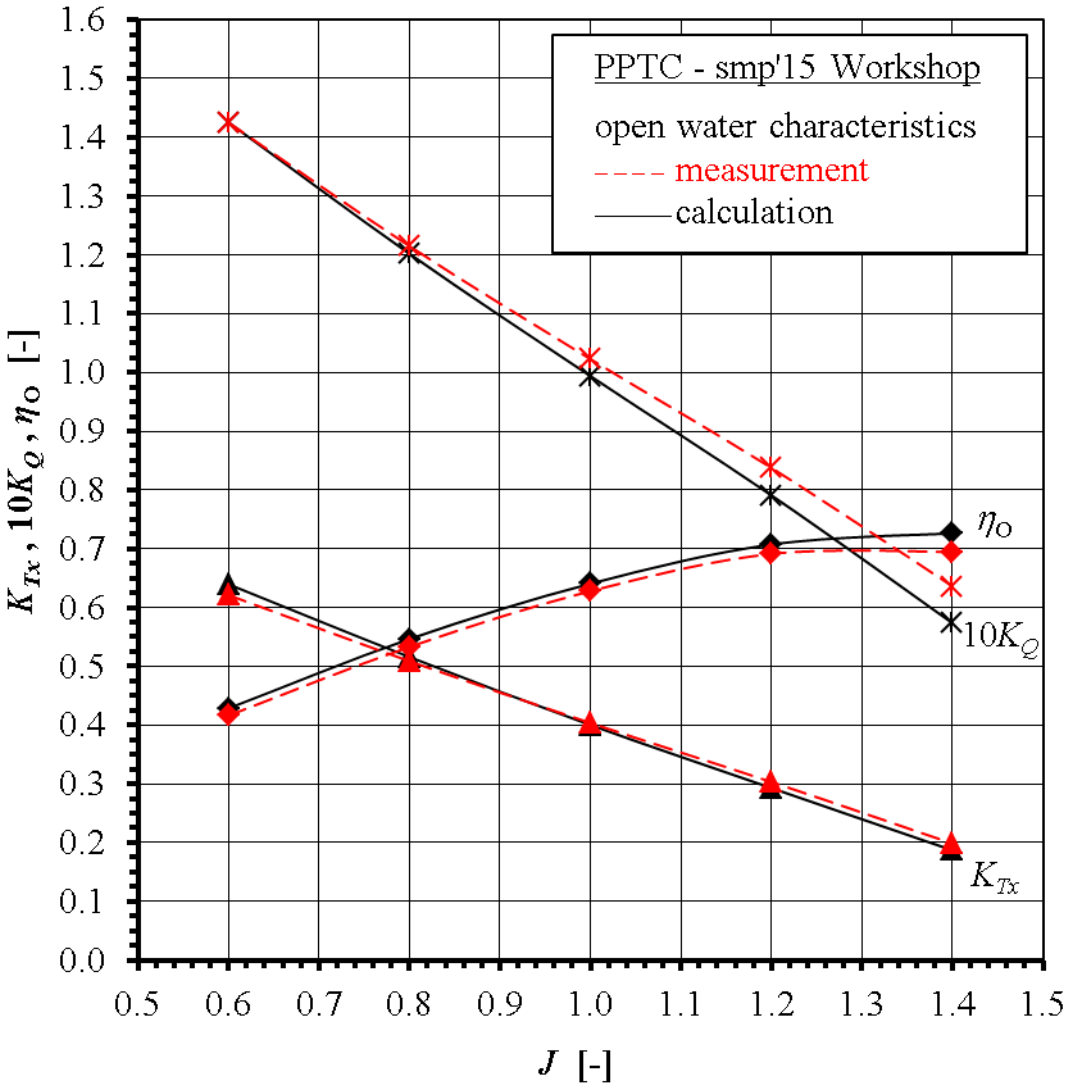


MARIN ReFresco



ROTAM Fluent




PPTC - smp'15 Workshop
open water characteristics
measurement
calculation
η_O
$10K_Q$
K_{Tx}
K_{Tx}, $10K_Q$, η_O [-]
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1.6
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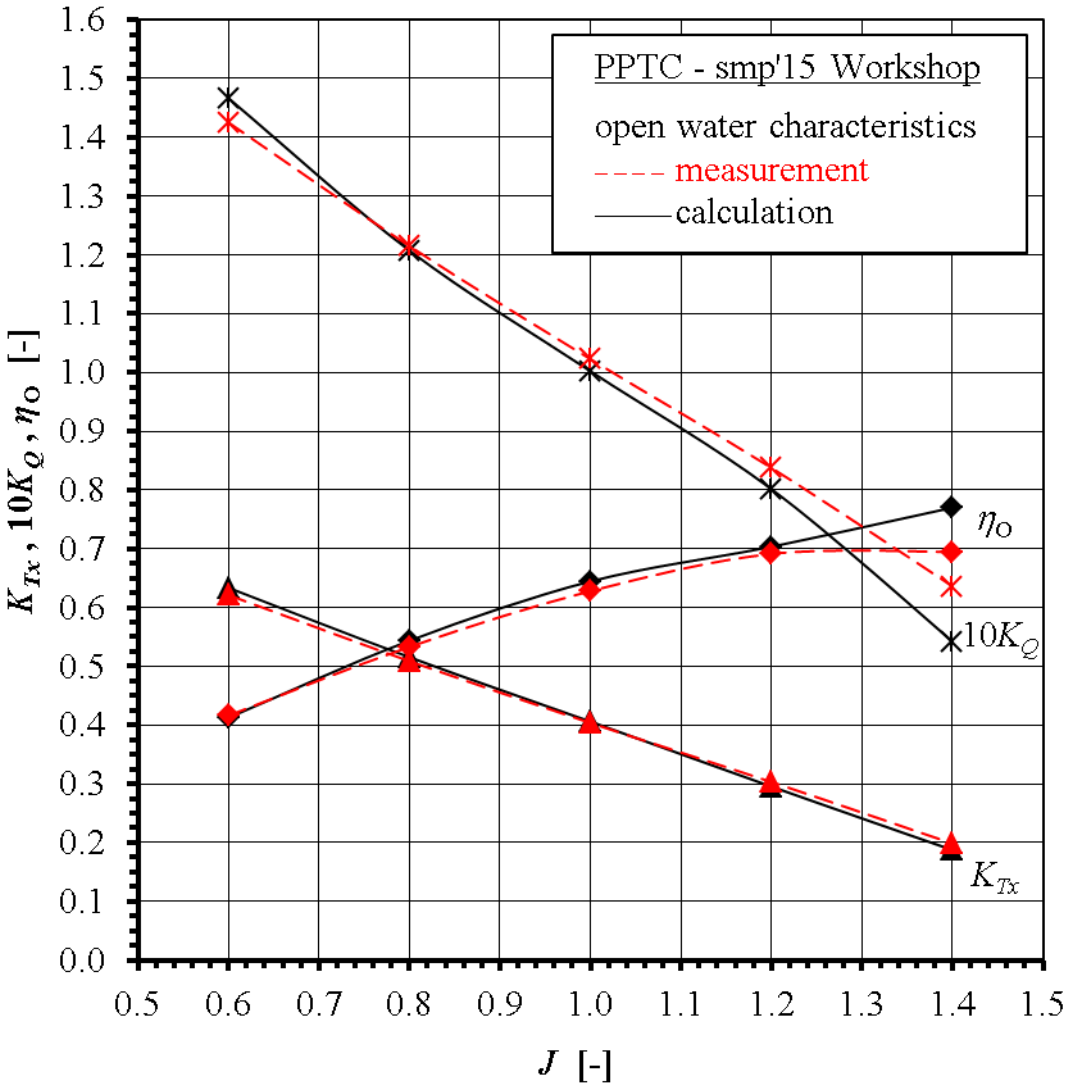
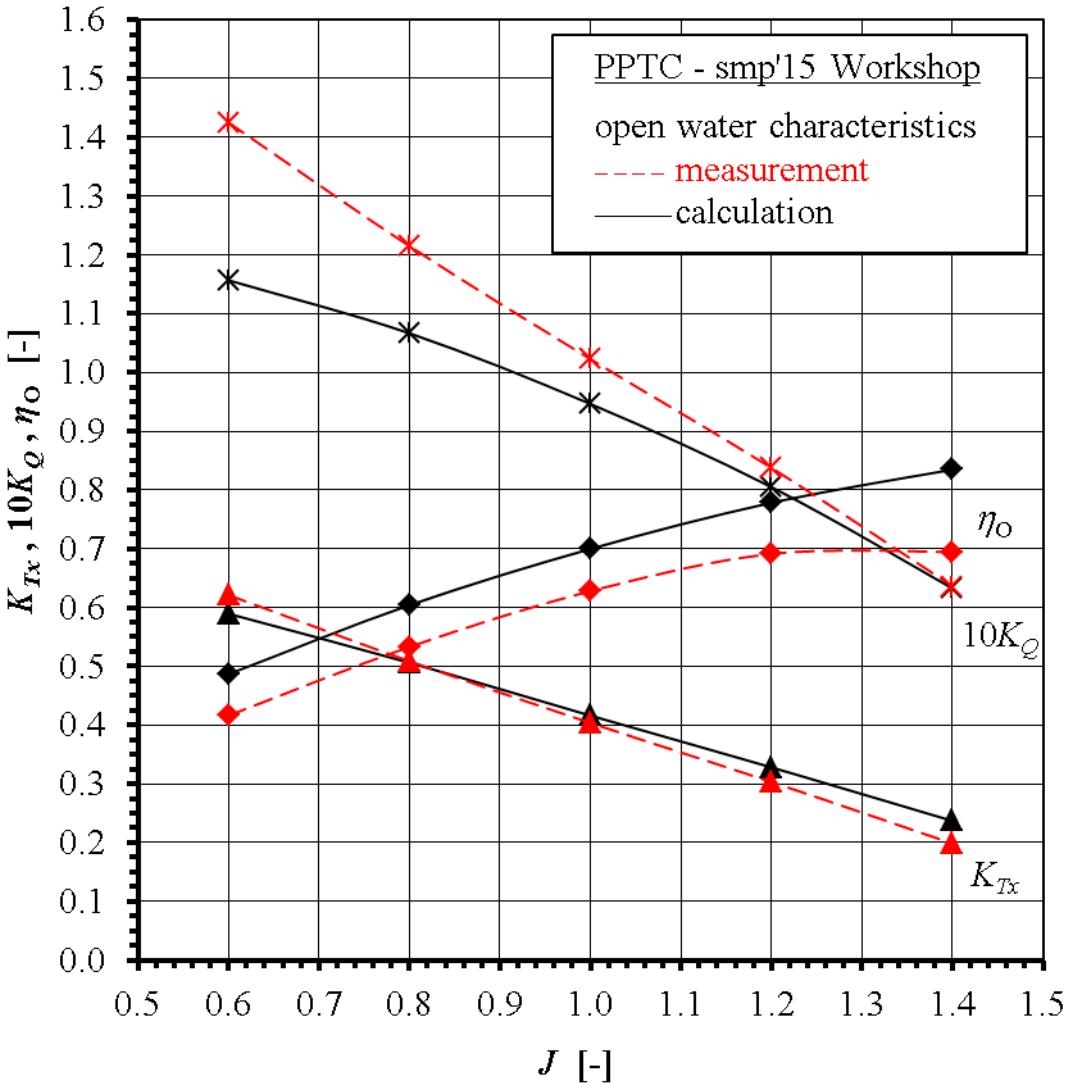
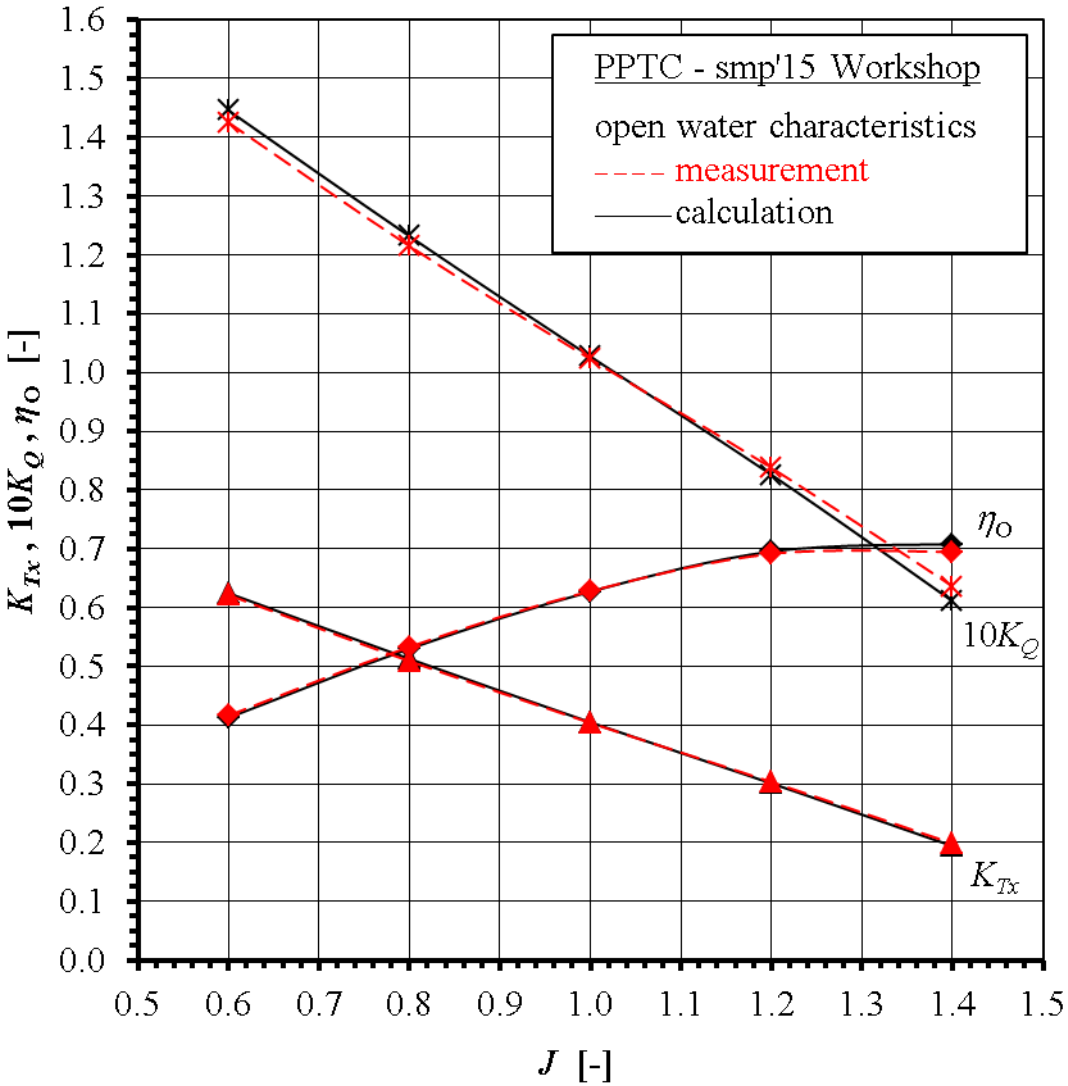
TUHH OpenFoam



TUHH panMARE

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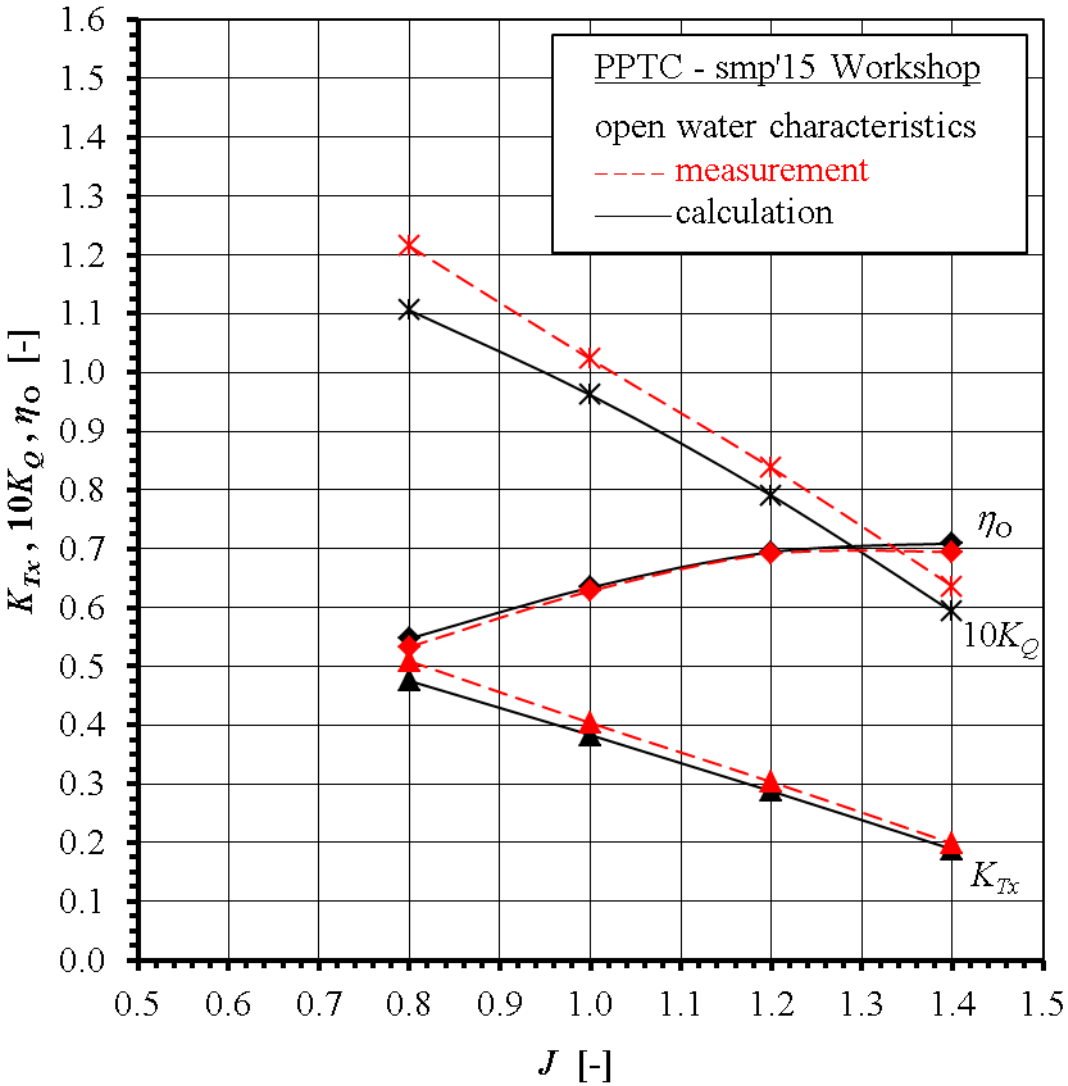
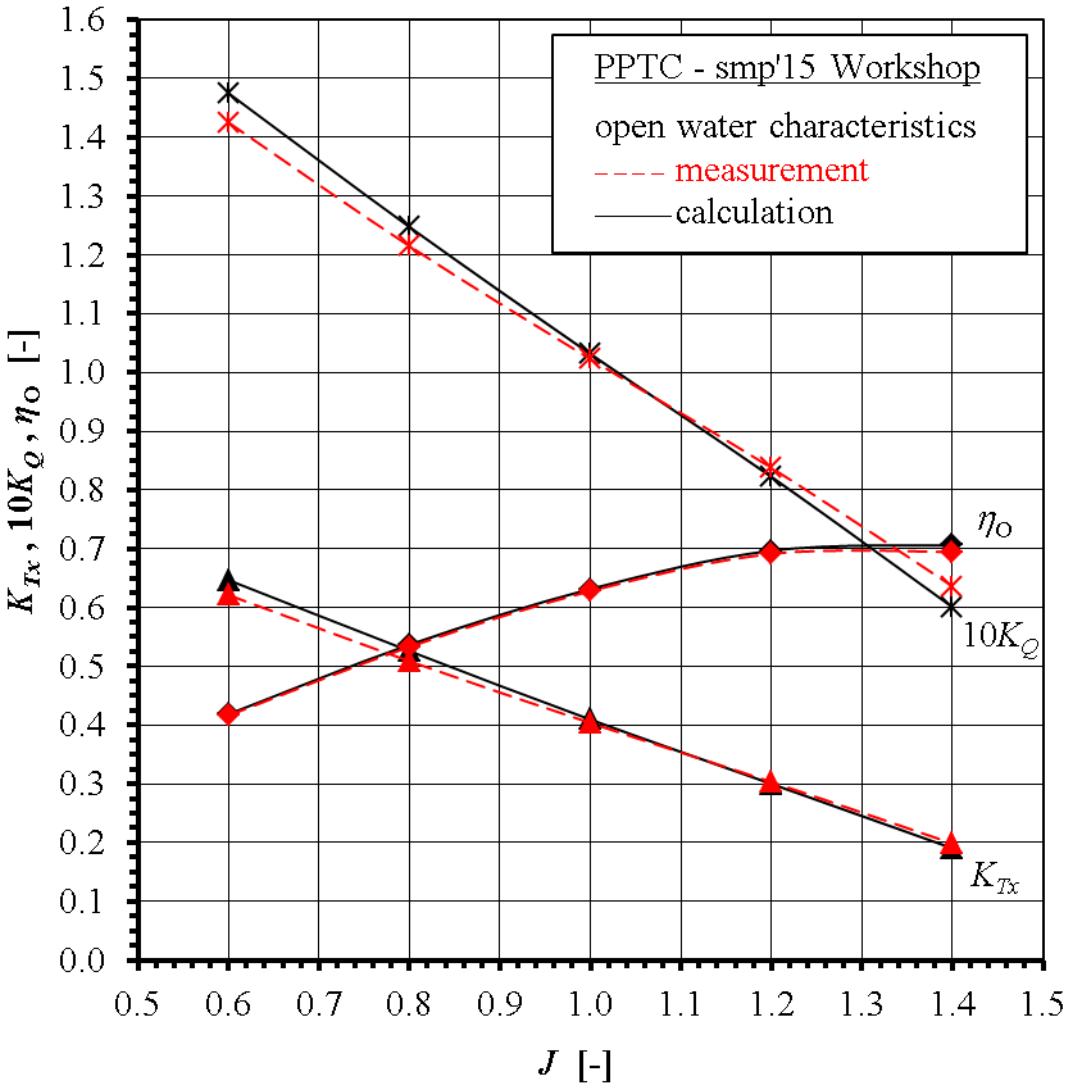
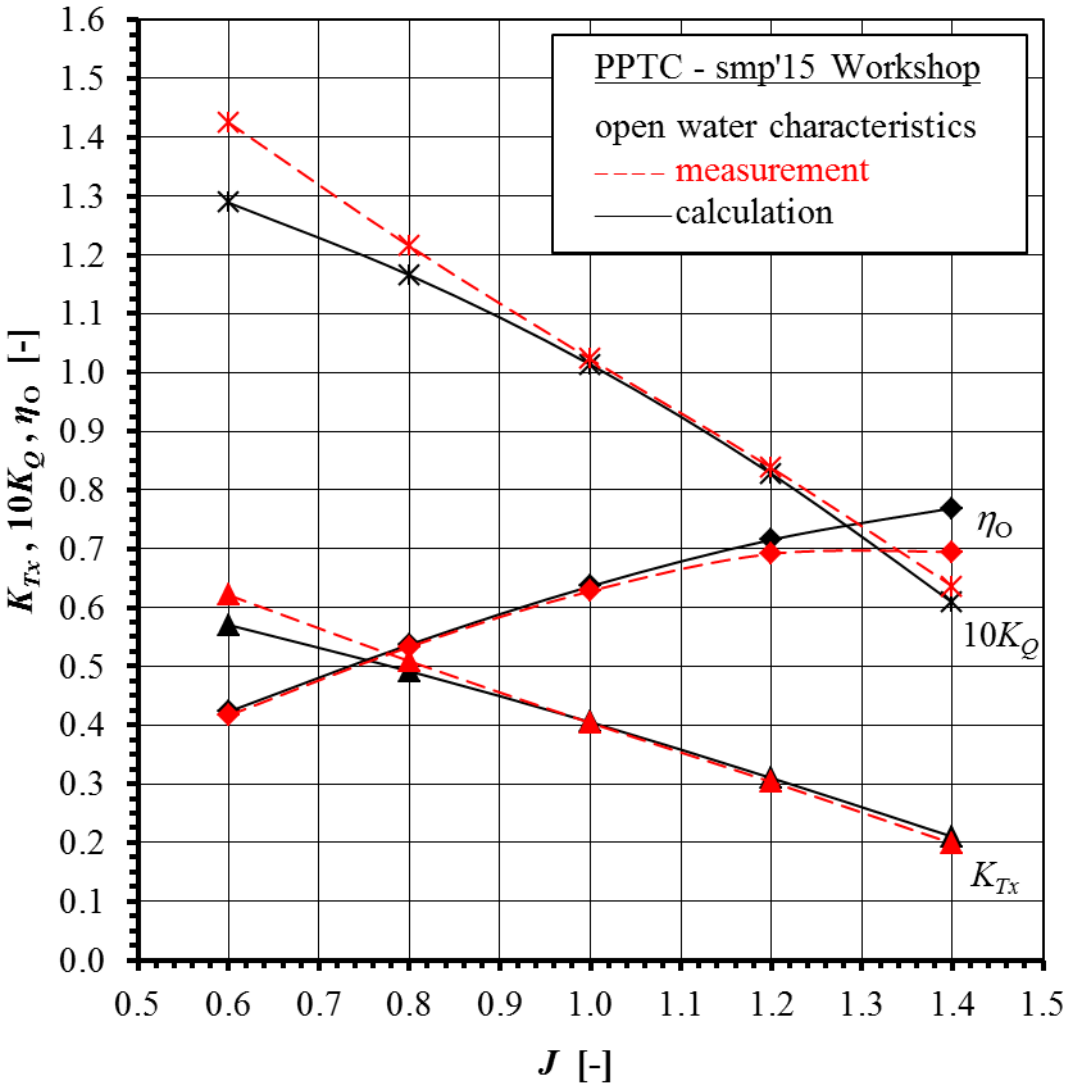
University of Genoa BEM



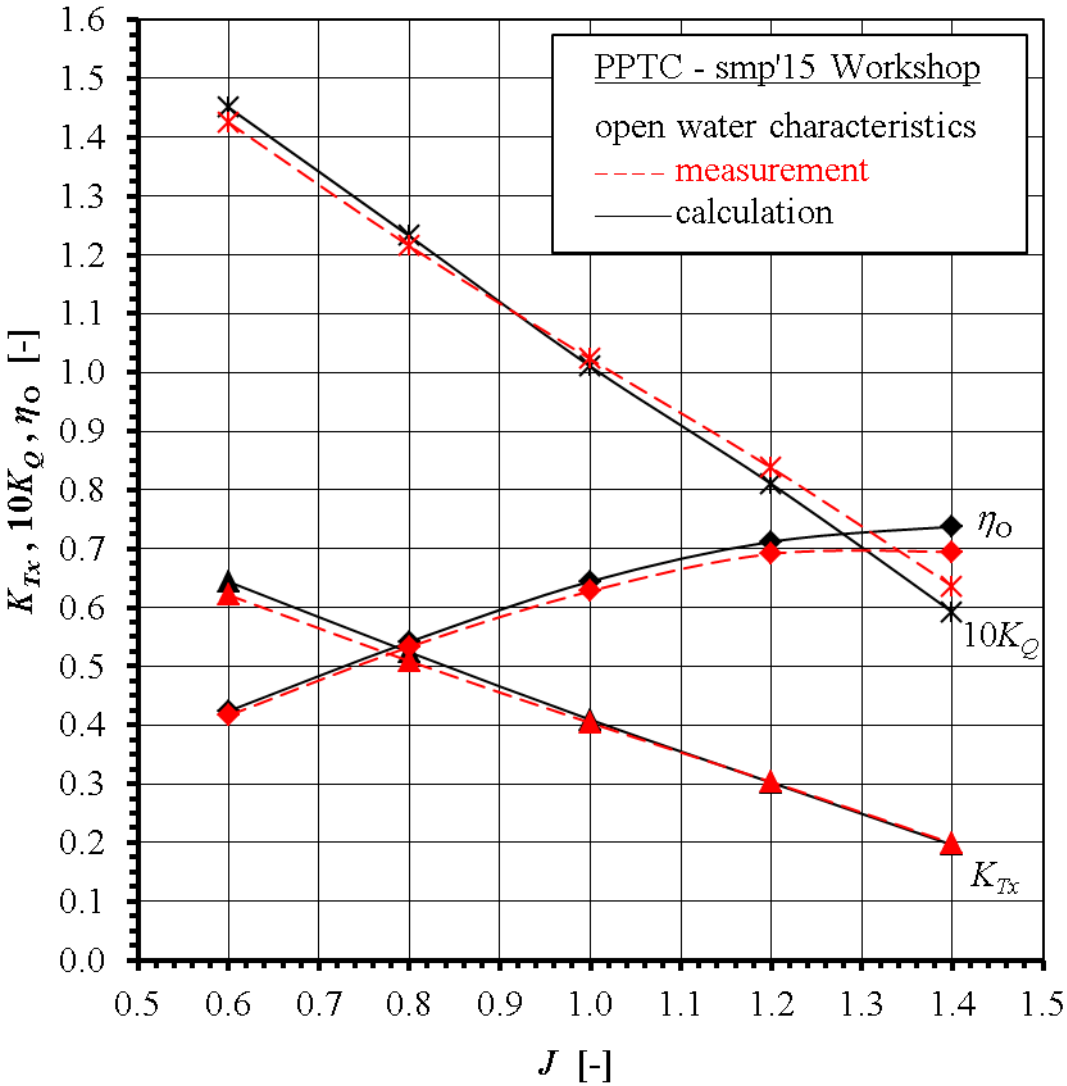
University of Genoa Star-CCM+



University of Austin PROPCAV



VTT FinFlo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K_{Tx}
K_{Tx}, $10K_Q$, η_O [-]
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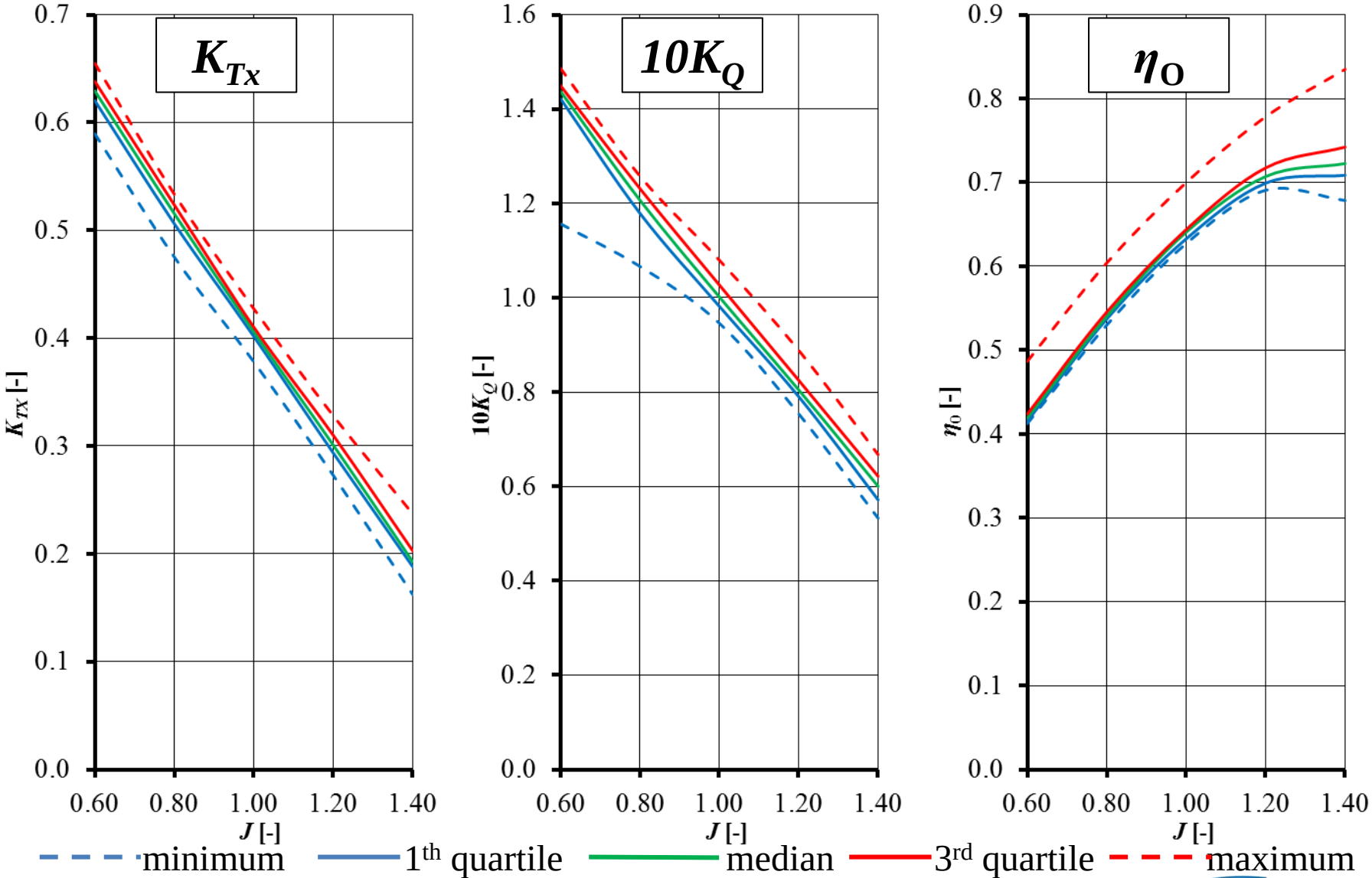
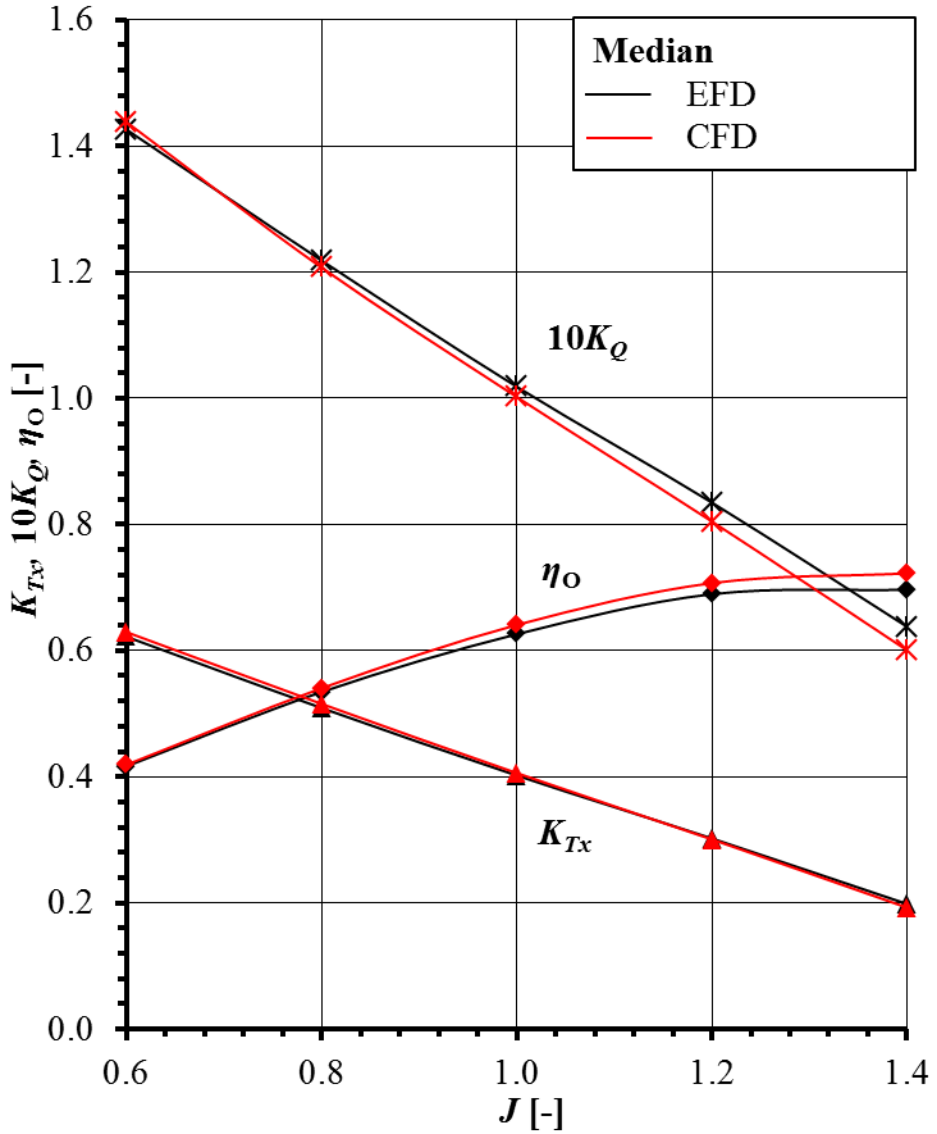
All characteristics - CFD



CFD vs. EFD


Median
EFD
CFD
$10K_Q$
η_O
K_{Tx}
K_{Tx}, $10K_Q$, η_O [-]
J [-]
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
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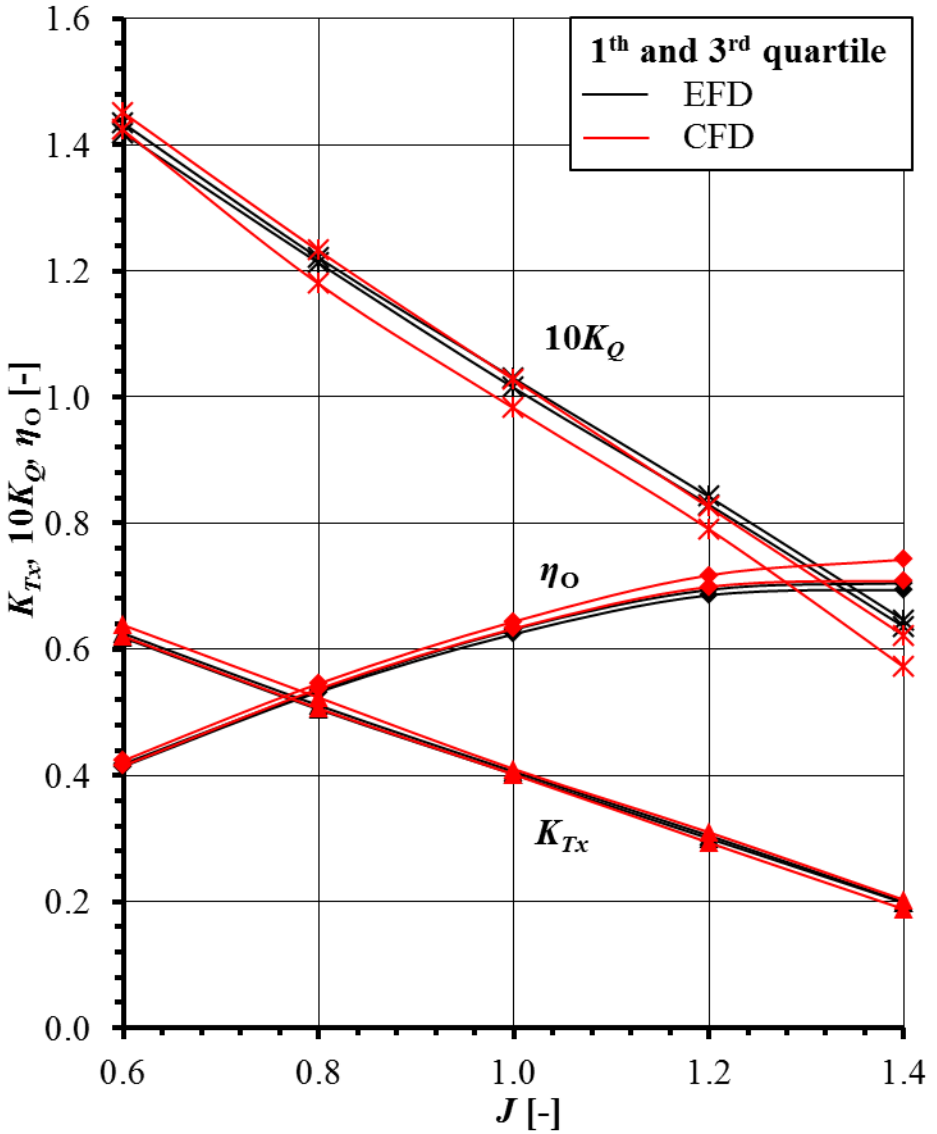
1.0
1.2
1.4


1th and 3rd quartile
EFD
CFD
$10K_Q$
η_O
K_{Tx}
K_{Tx}, $10K_Q$, η_O [-]
J [-]
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.6
0.8
1.0
1.2
1.4

Potsdam Propeller Test Case

Thank You!