- One possible integration basis is the permeate volume V, defined by:
  $\Pi_{meanV} = (1/V)*\int\Pi(V)*dV$

- Another possible integration basis is the membrane area A, defined by:
  $\Pi_{meanA} = (1/A)*\int\Pi(A)*dA$

The mathematical expressions of these averages are developed and presented in the paper.
Also, there are other averages for the osmotic pressure.

While Π_{meanV} is a thermodynamic entity, reversible in principle and thus having the minimal value – the other averages contain irreversiblities, discussed in the paper.

The same principle of several various averaging bases applies to the 4 other pressure differences.

In practice, the difference $\delta\Pi_{mean} = \Pi_{meanA} - \Pi_{meanV}$ may be as high as 3-5 bar. This difference applies in principle negatively to the NDP values:

$\delta\Pi_{mean} = -(NDP_{meanA} - NDP_{meanV}) = NDP_{meanV} - NDP_{meanA}$

One implication of $\delta\Pi_{mean}$ is that the energy and/or membrane area is/are "off-optimum", at least theoretically. Reduction of $\delta\Pi_{mean}$ by various possible means may save about 0.2-0.3 kWh/m³.

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Measurements of temperature polarization phenomena in membrane distillation channels by a thermographic technique

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The measurement of local temperature distributions within a membrane distillation (MD) module channel is a crucial step for the optimization of the channel and spacer geometry within the module. This information, in fact, allows estimating temperature polarization phenomena, which can dramatically influence the overall thermal process efficiency, leading to the optimal choice of module configuration (net spacer features, channel size, etc.) aiming at providing the best process performance. In the present work a recently presented experimental technique, based on the use of thermochromic liquid crystals (TLCs) and digital image processing, has been employed in order to measure the temperature and local heat transfer coefficient distribution on the membrane surface in a MD spacer-filled channel. Diamond spacer geometries were investigated, in order to highlight how the different geometrical features can affect both fluid dynamics and heat transfer phenomena in spacer filled channels.

Keywords: Membrane distillation; Thermochromic liquid crystals; Heat transfer; Temperature polarization; Fluid dynamics.