Heat Transfer Problem

[Image]

Assume that the view factor is 1 from very large plates, only radiation heat exchange, gray surface steady state heat transfer, constant properties, shield is thin such that there is no storage, and isothermal.

```
Solve[
 (300^4 - 100^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (300^4 - Ts^4) / ((1 / 0.8) + (1 / epss) - 1) &&
  (300^4 - 100^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (Ts^4 - 100^4) / ((1 / 0.4) + (1 / epss) - 1) &&
  (300^4 - Ts^4) / ((1 / 0.8) + (1 / epss) - 1) == (Ts^4 - 100^4) / ((1 / 0.4) + (1 / epss) - 1),
 {Ts, epss}, PositiveReals]
```

```
Solve[
 (T1^4 - T2^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (T1^4 - Ts^4) / ((1 / 0.8) + (1 / epss) - 1) &&
  (T1^4 - T2^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (Ts^4 - T2^4) / ((1 / 0.4) + (1 / epss) - 1) &&
  (T1^4 - Ts^4) / ((1 / 0.8) + (1 / epss) - 1) == (Ts^4 - T2^4) / ((1 / 0.4) + (1 / epss) - 1) &&
  T2 > T1 > 0 && 0 < epss < 1, {T1, T2, Ts, epss}, PositiveReals]
```

Monte Carlo Simulation of Problem

With a lucky guess at T_1 and T_2, we have constant emissivity everywhere, however there are poles and zeroes corresponding to certain temperature.

Solution simplex constrained by $T_2 > T_1 > 0$

In[•]:=
```
(*Assumehightemperaturesurfacehashighemissivity0.8*)

Plot3D[Evaluate[epss /. Solve[
     (T1^4 - T2^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (T1^4 - Ts^4) / ((1 / 0.8) + (1 / epss) - 1) &&
      (T1^4 - T2^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (Ts^4 - T2^4) / ((1 / 0.4) + (1 / epss) - 1) &&
      (T1^4 - Ts^4) / ((1 / 0.8) + (1 / epss) - 1) == (Ts^4 - T2^4) / ((1 / 0.4) + (1 / epss) - 1) &&
      T2 > T1 > 0 && 0 < epss < 1, {T1, T2, epss, Ts}]], {T1, 0, 1000},
 {T2, 0, 1000}, PlotRange → All, (*Adjusttheplotrangeasneeded*)
 AxesLabel → {"T1", "T2", "epss"},
 PlotLegends → Automatic]
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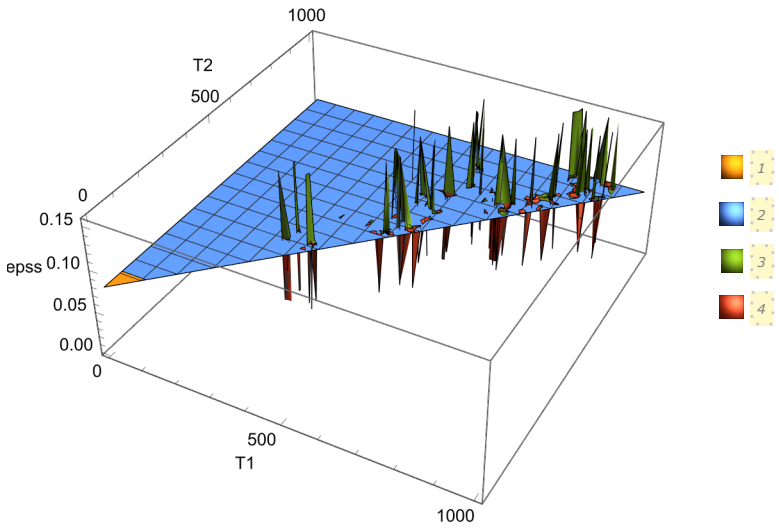
Out[•]=



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```
Plot3D[Evaluate[epss /. Solve[
    (T1^4 - T2^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (T1^4 - Ts^4) / ((1 / 0.8) + (1 / epss) - 1) &&
     (T1^4 - T2^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (Ts^4 - T2^4) / ((1 / 0.4) + (1 / epss) - 1) &&
     (T1^4 - Ts^4) / ((1 / 0.8) + (1 / epss) - 1) == (Ts^4 - T2^4) / ((1 / 0.4) + (1 / epss) - 1) &&
     T1 > 0 && T2 > 0 && 0 < epss < 1, {T1, T2, epss, Ts}]], {T1, 0, 1000},
 {T2, 0, 1000}, PlotRange → All, (*Adjusttheplotrangeasneeded*)
 AxesLabel → {"T1", "T2", "epss"},
 PlotLegends → Automatic]
```

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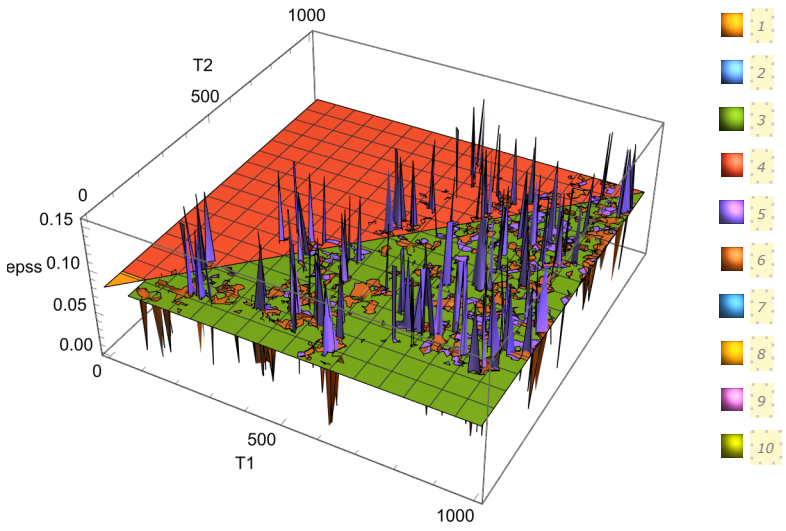

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```
(*Assumelowtemperaturesurfacehashighemissivity0.8*)

Plot3D[Evaluate[epss /. Solve[
    (T1^4 - T2^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (T1^4 - Ts^4) / ((1 / 0.4) + (1 / epss) - 1) &&
     (T1^4 - T2^4) / ((1 / 0.8) + (1 / 0.4) - 1) == 10 (Ts^4 - T2^4) / ((1 / 0.8) + (1 / epss) - 1) &&
     (T1^4 - Ts^4) / ((1 / 0.4) + (1 / epss) - 1) == (Ts^4 - T2^4) / ((1 / 0.8) + (1 / epss) - 1) &&
     T2 > T1 > 0 && 0 < epss < 1, {T1, T2, epss, Ts}]], {T1, 0, 1000},
 {T2, 0, 1000}, PlotRange → All, (*Adjusttheplotrangeasneeded*)
 AxesLabel → {"T1", "T2", "epss"},
 PlotLegends → Automatic]
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