A CFD mesh was generated for the above geometry, totaling 1.4 million cells—hexahedral in shape.

[0290] The CFD model described above was run at 12 different conditions:

[0291] Four (4) runs were conducted at "SMR" conditions, namely: T=800 C, P=2533000 Pa, ρ=5.067 kg/cu.m, inlet velocity=12.13 m/s to 37.6 m/s.

[0292] Four (4) runs were conducted at "water" conditions, namely: T=20 C, P=101325 Pa, ρ=998.2 kg/cu.m, inlet velocity=1.704 m/s to 5.284 m/s.

[0293] Four (4) runs were conducted at "air" conditions, namely: T=20 C, P=101325 Pa, ρ=1.205 kg/cu.m, inlet velocity=25.72 m/s to 79.49 m/s

In addition, these CFD runs were repeated at these conditions, but with a CFD model that was void of surface features for comparison purposes.

Basic key assumptions for these CFD analyses include:

[0294] 1. The channel was constrained to not include reactions.

[0295] 2. The flow was considered to be fully laminar.

[0296] 3. The entire flow-field was adiabatic.

[0297] 4. The flow was steady-state.

Calculations/Analysis

[0298] CFD results for these 12+12 runs are included below. The "Total dP" refers to the flow-fields pressure drop over the entire length. The "Developed dP" refers to the pressure drop occurring where the flow is considered periodic. The CFD results showed that the periodic region existed from 0.654 in. up to 10.066 in. Finally the pressure drop increase is also included.

Comparison of Pressure Drop, Surface Features vs. Flat-top, Laminar Flow
With Surface Features - Chevrons Developed Region (0.654 -> 10.066 in.)

Run Number	ReD [—]	Species [—]	Total dP [psi]	In. Velocity [m/s]	Density [kg/m^3]	Developed dP [psi]	Developed Fric. Factor [—]	Increase in dP [%]
1	1000.02	SMR	3.517	12.13	5.067	3.209	0.1462	53.2
2	1699.95	SMR	8.384	20.62	5.067	7.673	0.1210	100.8
3	2399.98	SMR	14.928	29.11	5.067	13.683	0.1082	135.8
4	3099.81	SMR	23.030	37.6	5.067	21.126	0.1002	162.1
5	1001.83	Water	13.662	1.704	998.2	12.465	0.1461	53.2
6	1703.22	Water	32.580	2.897	998.2	29.818	0.1209	100.9
7	2405.20	Water	58.043	4.091	998.2	53.199	0.1082	136.2
8	3106.60	Water	89.543	5.284	998.2	82.140	0.1001	162.3
9	997.50	Air	3.764	25.72	1.205	3.434	0.1463	52.9
10	1694.43	Air	8.961	43.69	1.205	8.201	0.1211	100.6
11	2389.81	Air	15.929	61.62	1.205	14.599	0.1084	135.3
12	3082.86	Air	24.509	79.49	1.205	22.482	0.1003	160.8

w/o Surface Features - FlatTop

Run Number	ReD [—]	Species [—]	Total dP [psi]	In. Velocity [m/s]	Density [kg/m^3]	Developed dP [psi]	Developed Fric. Factor [—]
1	1000.02	SMR	2.329	12.13	5.067	2.095	0.0955
2	1699.95	SMR	4.283	20.62	5.067	3.822	0.0603
3	2399.98	SMR	6.538	29.11	5.067	5.804	0.0459
4	3099.81	SMR	9.110	37.6	5.067	8.060	0.0382
5	1001.83	Water	9.043	1.704	998.2	8.134	0.0953
6	1703.22	Water	16.631	2.897	998.2	14.842	0.0602
7	2405.20	Water	25.371	4.091	998.2	22.521	0.0458
8	3106.60	Water	35.390	5.284	998.2	31.311	0.0382
9	997.50	Air	2.497	25.72	1.205	2.246	0.0957
10	1694.43	Air	4.581	43.69	1.205	4.088	0.0604
11	2389.81	Air	6.988	61.62	1.205	6.204	0.0461
12	3082.86	Air	9.739	79.49	1.205	8.619	0.0385

[0299] From these results, it was noted as a surprising result that the increase in pressure drop at a given Reynolds number was fairly independent of the actual fluid properties. In other words, at roughly a Reynolds number of 1000, a roughly 52 to 54% increase in pressure drop over the flat channel was seen for a fluid mixture of the steam methane reforming reaction (23 atm, steam to methane at 3 to 1 ratio), and 800 C as compared to fluids of either air (gas) or water (liquid) at 20 C and 1 atm. Similarly at a Reynolds number near 3000, the pressure drop ratio increase was closer to 160%. These remarkable results suggest that the degree of additional mixing as denoted by the increase in pressure drop is dominated by only the Reynolds number. These results are further surprising in that they translate from the laminar flow regime to the transition flow regime (Re ~3000). It is believed that the surface feature geometry and dimensions relative to the main flow channel will vary the absolute value of increase in pressure drop from flat to