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P. Spillantini: COMMENTS ON POSSIBLE CRYOGENIC GAS CERENKOV SUSTEMS. -

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ABSTRACT. -

Large solid angle Čerenkov counters using low temperature instead of high pressure gases could be useful to achieve full π/k separation over the momentum range up to a few GeV/c.

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Many experiments using the new high energy accelerators require π/k separation over a wide range of momentum and a large solid angle. Therefore a number of large Čerenkov hight radiators (solids, liquids or gases) must be included in the experimental apparatus. Solid and liquid radiators can be used up to $\sim$ 0.7 GeV/c, whereas gases at atmospheric pressure work satisfactorily from 4 GeV/c up. The remaining momentum interval 0.7 - 4 GeV/c (the most populated in many cases) can be covered by gases at pressures of several atmospheres, except possibly for its lower part, where liquified gases can be used(1). However, due to the large angular acceptance generally required, high pressure tanks create difficult technical problems and introduce heavy absorbers on the particle trajectories. Another way to solve the problem is to increase the gas density by decreasing its temperature, instead of increasing its pressure. This method is particularly useful choosing to work at the boiling temperature of the gas. At this temperature the presence of both the liquid and the vapour phases of the gas helps to achieve stable working conditions.

In many cases it might prove useful to collect also the Čerenkov light emitted by the liquified portion of the gas. Such a complete cryogenic system working at atmospheric pressure could distinguish π's from k's in the $\sim 0.5 - 10$ GeV/c momentum range, except possibly a relatively narrow interval. This interval could however be covered using moderately high pressures.

As an example we report in Table I the properties of some gases relative to Čerenkov light emission at atmospheric pressure for both liquid and vapour.

The pressures to be applied to a liquid+saturared vapour cryogenic system for full π/k separation for momenta up to a few GeV/c are reported in Table II. These pressures could be further reduced using two different gasses for the liquid and the gaseous radiators.

In particular if the problem of the scintillation could be avoided, liquid He together with He (or H_2 or Ne) saturated vapours at their boiling temperatures should provide full π/k separation at atmospheric pressure.

REFERENCES.-

(1) - P. Spillantini, Čerenkov light detection from a liquid hydrogen counter, Nucl. Instr. Meth. 119, 583 (1974).

TABLE I

Gas	Boiling temperature at atmospheric pressure (in °K)	Density at atmospheric pressure (in g/cm³)				Refractive index at atmospheric pressure			Momentum interval useful for π/k separation for a threshold of a half of the maximum Čerenkov effect (in GeV/c)			Photons/cm detected using a bialkali (type D) photocatode		
		room T. vapour	saturated vapour	norm/sat. vapour	liquid	room T. vapour	saturated vapour	liquid	room T. vapour	saturated vapour	liquid	room T. vapour	saturated vapour	liquid
He	4.21	0.1656	16.714	7.5	125	1.000035	1.00354	1.0206	23-80	2.35- 8.3	0.95 -3.40	0.03	3.3	18
H_2	20.38	0.0834	1.332	53.3	71	1.000134	1.00215	1.111	12-43	2.95-10.6	0.41 -1.45	0.12	2.0	84
Ne	27.09	0.8354	9.552	126.3	1206	1.000067	1.00077	1.10(x)	17-60	4.9 -18.0	0.43 -1.52	0.06	0.7	76
N_2	77.36	1.161	4.604	174.5	804	1.000294	1.00116	1.205	8.2-29	3.95-14.5	0.29 -1.02	0.27	1.1	140
A	87.28	1.656	5.763	242.0	1394	1.000284	1.00099	1.23	8.4-30	4.3 -15.5	0.275-0.97	0.26	0.9	152
O_2	90.18	1.327	4.467	254.0	1124	1.000271	1.00088	1.221	8.6-31	4.5 -16.5	0.28 -0.99	0.24	0.8	148
CH_4	111.66	0.7174	1.807	234.5	424	1.000440	1.00111	1.29	6.6-23	4.0 -14.7	0.24 -0.84	0.41	1.0	180
Kr	119.87	3.48	8.7	278	2415	1.000427	1.00106	1.315(x)	6.7-24	4.1 -15.0	0.225-0.81	0.39	0.9	190
Xe	165.04	5.47	11.5	266	3057	1.000702	1.00152	1.45(x)	5.0-18	3.45-12.5	0.180-0.66	0.65	1.8	230

(x) - These refractive indexes have been deduced from those of the corresponding vapour using the Clausius-Mossotti relation.

TABLE II

Gas	$P^{(x)}$ (atm)	$T^{(x)}$ (^{o}k)	Properties of liquid and saturated vapour for $P = P^{(x)}$								
			density (g/cm^3)		refractive index		Photons/cm detected using a bialkali (type D) photocathode		Momentum interval useful for π/k separation for a threshold of a half of the maximum Čerenkov effect (in GeV/c)		
			saturated vapour	liquid	saturated vapour	liquid	saturated vapour	liquid	saturated vapour	liquid	total
He	0.47	3.5	8.25	136	1.00175	1.0225	1.6	19	3.2 -11.8	0.90-3.2	0.90-11.8
H_2	4.0	26	4.93	60	1.0080	1.0944	7.2	72	1.6 - 5.6	0.44-1.6	0.44- 5.6
Ne	8.2	37	74.5	990	1.0061	1.082	5.5	64	1.7 - 6.4	0.48-1.7	0.48- 6.4
N_2	12.9	108	55.3	634	1.0139	1.162	12.4	115	1.16- 4.2	0.33-1.16	0.33- 4.2
A	17.5	127	89.9	1095	1.0154	1.180	13.8	126	1.10- 4.0	0.31-1.10	0.31- 4.0
O_2	18.0	131	41.4	875	1.0141	1.172	12.6	120	1.15- 4.2	0.32-1.15	0.32- 4.2
CH_4	19.0	163	30.7	326	1.0189	1.224	16.5	150	0.98- 3.6	0.28-0.98	0.28- 3.6
Kr	21.2	179	168	1810	1.0205	1.237	18	157	0.96- 3.4	0.27-0.96	0.27- 3.4
Xe	20.9	241	218	2300	1.0289	1.339	25	200	0.79- 2.9	0.22-0.79	0.22- 2.9

(x) - Thermodynamical conditions at which the momentum intervals useful for π/k separation using liquid and satura ted vapour Čerenkov hight radiators are contiguous.