

PROCESS FOR PURIFYING DIARYL CARBONATES

BACKGROUND OF THE INVENTION

5 Field of The Invention

The invention relates to processes for the purification of diaryl carbonates such as diphenyl carbonate.

Brief Description of Related Art

10 Diaryl carbonates such as diphenyl carbonate may be prepared by a number of processes. For example, one process is based on the phosgenation of aromatic hydroxy compounds in the presence of a quaternary ammonium salt catalyst. A variant
15 process comprises phosgenation at elevated temperatures in alkaline solution. A commercial process for production of diphenyl carbonate comprises phosgenation of phenol in the presence of caustic at a pH of 10-11 and at a temperature of
20 55°-60°C.

Commercial preparations of diaryl carbonates, regardless of the process employed, inevitably contain various contaminant compounds in varying quantities. Examples of contaminants which have
25 been identified are inorganic and organic chlorides, metal ions, iron compounds, acidic compounds such as aryl chloroformates and a range of compounds identified only as "color bodies". These contaminants frequently effect use of the
30 diaryl carbonates in particular applications. For example, when their desired use is as a monomer reactant in the preparation of aromatic polycarbonate resins by transesterification (using bisphenol-A and diphenyl carbonate), presence of
35 the contaminants can affect polymerization rates

and resin color. The polymer product may have a low intrinsic viscosity (IV) and colors ranging from pink (iron contamination) to brown (phenyl chloroformate contamination).

5 Although distillation of diaryl carbonates has been useful to remove color bodies and solves the problem of coloration in the carbonate and resins prepared from them, the procedure has not been useful to remove other contaminants responsible for
10 inhibiting polymerization rates. In fact, a major drawback of distilled diphenyl carbonate is a loss of reactivity as observed in ester interchange reaction studies. The reason is open to speculation. Also, subjecting the diaryl
15 carbonate, such as diphenyl carbonate, to distillation solely as a means of purification results in a percentage of product loss, which is an economic disadvantage.

 Relatively crude diaryl carbonate containing
20 contaminants associated with the process of preparation may be purified advantageously by a two-stage procedure to optimize overall yield of the desired product and remove contaminants. The first stage is washing a melt of the diaryl
25 carbonate with water; followed by a second distillation stage. An intermediate cut taken during distillation between the first and last (product) cuts helps to isolate color bodies and contaminants responsible for producing low
30 intrinsic viscosity and/or colored polymer resins therefrom. The distilled product is of improved reactivity and high purity, when the distillation procedure is immediately preceded by a hot aqueous wash. Water washing of the crude diaryl

carbonate helps reduce the content of contaminants including iron, and improves final color in polymers prepared from the purified diaryl carbonate.

I have found that diaryl carbonates can also
5 be readily separated and purified by
crystallization from molten crude feedstocks. The
crystallizations may be carried out by both falling
film crystallization, and static melt
crystallization methods. In principle, both these
10 methods are fundamentally the "same", in that
crystals, rich in the desired product are caused to
separate from the impure melt by carefully and
slowly lowering the melt temperature. Carefully
lowering the temperature from the point where
15 nucleation occurs, until a certain desired low
temperature is reached, causes the liquid to be
continuously saturated with the dominant component,
thereby resulting in the formation of a solid phase
(crystals), rich in the desired diaryl carbonate.
20 The process of the invention may be carried
out to obtain pure diaryl carbonates in a
continuous or a batch procedure, with an advantage
in that the product is consistently obtained in
high purity.

25 SUMMARY OF THE INVENTION

The invention comprises a process for
purification of diaryl carbonates, which comprises;
providing a crude solution of diaryl carbonate
in admixture with contaminant by-products of the
30 diaryl carbonate preparation;
cooling the solution to a temperature of about
1-2°C. below the nucleation temperature of the
diaryl carbonate, whereby nucleation occurs;
cooling the solution containing nucleated
35 diaryl carbonate at a controlled rate, between

about 0.01 to 1.0°C. per minute whereby crystals of the diaryl carbonate form in a residue of cooled solution;

separating the residue of solution from the
5 formed crystals of the diaryl carbonate;

heating the separated crystals at a controlled rate to their melt temperature, incrementally;

separating sweat exuding from the heated crystals in each increment; and

10 collecting the melted crystals to obtain high purity diaryl carbonate.

Near theoretical yields of the diaryl carbonate can be recovered in a semi-continuous embodiment process of the invention whereby the
15 separated sweats and solution residues are recycled through the process for repeated fractional melt crystallization.

BRIEF DESCRIPTION OF THE DRAWING

The accompanying drawing is a schematic
20 showing a preferred embodiment apparatus for carrying out the process of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS OF THE INVENTION

The following description will be directed to
25 a preferred embodiment process of the invention for purification of diphenyl carbonate (DPC). Those skilled in the art will appreciate that the inventive process is applicable to purification of other diaryl carbonates, such as for example, di-
30 ortho-cresyl carbonate, di-ortho-chlorophenyl carbonate and the like.

With reference to the accompanying drawing, there is seen a schematic drawing of a static crystallizer assembly 10 for carrying out the
35 purification of a diaryl carbonate contained in a

crude product obtained for example by phosgenation of a phenol reactant compound.

A portion of melted crude diphenyl carbonate (DPC) feedstock obtained as a product of the preparation is added through the top end (13) of crystallizer jacketed tube (12). After precooling, the temperature of the crude melt is held at a constant temperature, 1-2°C. below the nucleation temperature of the DPC in the crude mixture. Once nucleation has occurred, the temperature is ramped downward slowly at a controlled rate, typically between about 0.01-1.0°C. per minute by circulating a heat transfer medium such as cooling water through the jacketed tube 12 via inlet 14 and outlet 16. Temperature control means 18 maintains a desired temperature ramp and control of the temperature in crystallizer assembly 10 and can be verified by thermometer (24). Crystallization proceeds as the cooling feedstock liquid continues to saturate, forming crystals which attach to the interior wall surface (22) of the crystallizer (10).

When the desired lowest temperature is reached, the bottom valve (20) is opened, and the uncrystallized liquid feedstock residue containing concentrated impurities is drained away from the crystallizer (10).

After the feedstock residue is separated, the temperature of crystallizer (10) is raised incrementally at a controlled rate to bring about a "sweating" or partial melting of the collected crystals. The optimal sweating temperature ramp, as well as the initial crystallization temperature ramp, are determined experimentally by trial and error technique to maximize purification per

increment or stage, and to maximize the overall yield of the multi-stage process. Thus in a preferred embodiment process of the invention, residues and sweat liquors obtained from higher
5 purity stages are "added back" to the feed of lower purity stages, until a purified product is taken from the highest yield stage, and residue for recycling in the process is taken from the lowest yield stage.

10 Table 1 below is a mass distribution diagram of one stage of the process of the invention with a static crystallization. One can see that substantial purification of the desired product (DPC), is accomplished by observing the DPC content
15 of the feedstock (53.7% DPC) vs the melt product (96.7% DPC). It is obvious that the process using multiple stages will lead to very high purity.

Determination of the number of stages required to reach a predetermined purity and color, and the
20 overall yield and efficiency may be derived by trial and error technique.

The following example describes the manner and process of carrying out the invention and sets forth the best mode contemplated by the inventor,
25 but is not to be construed as limiting the scope of the invention.

EXAMPLE

334 grams of crude diphenylcarbonate (DPC) feed (53.7% DPC) was melted and placed in the
30 static crystallizer (10). The temperature was cooled quickly to around 53°C. Nucleation occurred at 53.8°C. The cooling ramp was started at 0.13 degrees per minute, and continued until it reached 30°C. At this point, the bottom valve (20) was
35 opened, and the liquid residue allowed to drain for

approximately 1 hour. The temperature was then raised in 10°C. increments, and held for one hour at each level while the "sweat" was collected. finally, after collecting the 75°C. sweat, the
 5 temperature was raised to 85°C. to quickly melt the product from one stage. All the fractions, residues and the starting solution were analyzed by high pressure liquid chromatography (HPLC) to determine the DPC content of each, and therefore
 10 the mass distribution of recovered DPC which is shown in Table 1, below.

TABLE 1

	<u>Weight</u> <u>(gms)</u>	<u>DPC (%)</u>	<u>DPC</u> <u>(Grams)</u>
15 Crude Starting Solution	333.55	53.74	179.3
Residue Removed after			
20 crystallization	89.67	20.32	18.2
Sweat 1	41.04	21.12	8.7
Sweat 2	25.76	32.59	8.4
Sweat 3	26.41	32.59	8.6
Sweat 4	44.66	72.93	32.6
25 Sweat 5	32.4	86.56	28.1
Melt	73.4	96.67	<u>71.0</u>
Total Recovered			175.6

In a preferred embodiment process of the invention, the sweats 4 and 5 would be added to the
 30 residue after crystallization and mixed with or used as the crude starting solution in a subsequent multi-stage processing in order to recover a maximum yield of the desired DPC product.

**WHAT IS CLAIMED IS:**

1. A process for purification of diaryl carbonates, which comprises;
providing a crude solution of diaryl carbonate in admixture with contaminant by-products of a
5 diaryl carbonate preparation;
cooling the solution to a temperature of about 1-2°C. below the nucleation temperature of the diaryl carbonate whereby nucleation occurs;
cooling the solution containing nucleated
10 diaryl carbonate at a controlled rate, between about 0.01 to 1.0°C. per minute whereby crystals of the diaryl carbonate form in a residue of cooled solution;
separating the residue of cooled solution from
15 the formed crystals of the diaryl carbonate;
heating the separated crystals at a controlled rate to their melt temperature, incrementally;
separating sweat exuding from the heated crystals in each increment; and
20 collecting the melted crystals to obtain high purity diaryl carbonate.
2. The process of claim 1 wherein the diaryl carbonate is diphenyl carbonate.
3. The process of claim 1 wherein the sweats are recycled into the residue for repeating the process of claim 1.
4. The process of claim 1 wherein the residue is employed as provided crude solution in a continuous process.